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STATISTICAL PACKAGE USER'S GUIDE

Julie A. Hopson and George A. Cotsonis

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NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY

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ERRATA SHEET for NAMRL Special Report 80-3

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Julie A. Hopson and George `. Cotsonis

The following corrections should be made to subject report.

Page No.	Line No.	Correction
iii	II.B.4.	ANOVA, One Repeated Measure vice ANOVA, Repeated Measures
iii	II.C.2.	One-way ANOVA vice Two-way ANOVA
iv	II.D.6.	Rotation vice Location
54	22	Add as last sentence to Test Data: The same data used in SRM30 (See SRM30) was used for testing program.
41	12	$X_{ij} = u$ vice $X_{ij} = i$
61	1	One Repeated Measure vice Repeated Measures
77	12	$B_j + C_k$ vice $B_j - C_k$
110	24	Add the following columns to the bottom of page:

RAW DATA

3.000	4.000	7.000	7.000
6.000	5.000	8.000	8.000
3.000	4.000	7.000	9.000
3.000	3.000	6.000	8.000
1.000	2.000	5.000	10.000
2.000	3.000	6.000	10.000
2.000	4.000	5.000	9.000
2.000	3.000	6.000	11.000

Page No.	Line No.	Correction
144	13/15	$(X_{ijm} - \bar{X}_{ij.}) = u + A_i + B_j + AB_{ij} + \P_{m(i)} + B\P_{jm(i)} + E_{ijm}$ vice $(X_{ijm} - \bar{X}...) = u + A_i - B_j + AB_{ij} + \Sigma_{m(i)} + B\Sigma_{jm(i)} + E_{ijm}$
164	1	One-way ANOVA vice Two-way ANOVA
174	12	$= u_{(r)}$ vice $= M_{(r)}$
247	1	(Varimax Rotation) vice (Varimax Location)

STATISTICAL PACKAGE USER'S GUIDE

Julie A. Hopson and George A. Cotsonis

Approved by

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August 1980

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SUMMARY

The Statistical Package User's Guide represents an aggregation of a variety of statistical analysis. The types of statistical programs available are: Analysis of Variance, Analysis of Covariance, Multivariate Analysis of Variance, Regression Analysis, Factor Analysis, Descriptive Statistics, and Nonparametric Statistics. The User's Guide provides the following documentation for each program: General Description, Mathematical Model, Operational Procedures, Test Data Statistical Analysis, and Software Coding.

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INTRODUCTION

The Statistical Package User's Guide represents an attempt to aggregate a variety of statistical programs in the Aerospace Psychology Department at the Naval Aerospace Medical Research Laboratory (NAMRL) into one standard package. Some of the statistical programs included in the statistical package were developed at the Naval Aerospace Medical Research Laboratory for the UNIVAC 418 and NOVA 800; others were programs obtained from different universities with multifarious computer capability and programming languages. Selection of programs in the statistical package was based upon investigator needs and computer core requirements. The intention was to provide a diversity of basic statistical programs for experimental investigators which matched research requirements and which could be readily utilized in the majority of the Naval Aerospace Medical Research Laboratory computer facilities.

For standardization, all statistical programs were coded in Fortran IV language and sized to fit a mini-computer with 32k memory. The programs were originally converted to a Hewlett Packard (HP) 2100 mi.·-computer but were structured so that only minor changes in the input/output (I/O) require- ments (i.e., device codes and disk file formats) would be necessary for the statistical package to be compatible with another system. Programs were also structured so that they could be used by investigators with limited computer skills. It was intended that the organizational/structural phi- losophy of the statistical package serve as a guideline for new programs. If the same general philosophy is adhered to when developing other statistical analyses, new programs could be readily shared by multiple users, thereby expanding the statistical package with minimal programming efforts and costs.

Once the programs were converted to the HP mini-computer, each was checked carefully for accuracy. Documented data were obtained from specific sources to check the calculation of the statistical analyses. An estimate of the digit accuracy was obtained by comparing the results of the HP calculation with those obtained from other computing sources. Most comparisons were made using the Statistical Analyses System and the Statistical Package for Social Sciences, two data analysis packages residing on the IBM 360 system at University of West Florida. Most of the programs were accurate to ten digit places; exceptions to this are noted in the user's guide. When comparison analyses were done with systems that had less computing power than the HP-2100, double precision was used in the calculations to insure minimal rounding-off errors. All data analyses performed on the HP-2100 have been included in the guide so that calculations can be double checked if a malfunction is suspected or to verify whether the operator is entering the data properly.

Standard operating procedures for a specific system is the only computer skill needed to use the statistical package. It will be necessary to generate a separate data file prior to calling up a specific analysis. The data files can either be created using DA30 or constructed during an experimental un. The format of the data is dependent upon the desired statistical analysis and is specified in the guide. When a data file is not organized appropriately, edit or sorting commands of the system being used is typically adequate to rearrange files in the necessary format. For other systems, it may be desirable to write a generalized utility program to change data file organization.

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The notation used for the formulas in the statistical package should be familiar to the general user. Although alphanumeric letters are used in the models rather than standard greek letters, with the exception of Tau (π), the reader should have no difficulty in interpreting the equations. For a few cases, computer notation was used (i.e., transformation equations). For these, the following notiation is utilized:

* = multiplication sign

$x** = x^2$

$x**^{.5} = \sqrt{x}$

The Analysis of Variance and Covariance programs were given two names; i.e., AV10 and CR-k. Since these analyses were developed from designs specified by Roger E. Kirk, <u>Experimental Design Procedures for the Behavioral Sciences</u>, the unique nomenclature he used for specific designs was maintained in the guide for reference. When calling up any of these statistical programs, only the AV or AC notation will be accepted. For the split-plot analyses the AV notation is accompanied by alphanumeric letters to indicate which factors are the within variables. AV31C means that A and B are the between group factors and C the within factor.

I. UTILITY PROGRAMS

DA30 (Data File Creation)

Purpose:

    This program creates data files for the stat-pack on the HP2100.
The data are entered by hand at the computer console and permanently
stored on the disc.

User Considerations and Procedures:

1.   Check "User Considerations and Procedures" of the various statistical
programs to see how the data should be formatted - some require data
in matrix form, others in sequential form.

2.   DA30 will ask for the following

    a.   format for data output. This is the format per line of data
required for the statistical program. Respond by giving any
legal HP-FORTRAN IV format statement, enclosing the format in
parentheses. For example:

        1) (15)
        2) (15, F7.3, F9.7, 16)
        3) (30, (1X, F10.4))

        NOTE: The word format should not be given.

    b.   logical record length. This is the number of characters per
line of data created. Spaces should be included. For the
example above, the record lengths are:

        1) 5
        2) 5 + 7 + 9 + 6 = 27
        3) 30 * (1 + 10) = 30 * 11 = 330

        The maximum length is 512 characters per line.

    c   number of observations across. This is the number of variables
per line. (Some statistical programs require one per line,
others require many.) For the three examples above, this is:

        1) 1
        2) 4
        3) 30

d. number of levels down. This is the number of records to be
    created in the file. The maximum number of records that can
    be contained in a file is 32767.

e. data file name. Enter name of the file to be created (maximum
    of six characters)

    NOTE: Imbedded blanks are illegal. Do not use a name that is
           already stored on the disc.

3. Procedures for entering data via keyboard:

    a. to enter only one variable per record, enter value, then hit
        'return'

    b. to enter 10 or fewer variables per record, enter the values
        by row, separating each with a comma. Terminate the row with
        a 'return'

    c. to enter more than 10 variables per record, enter data across
        in groups of 10 variables. Separate each variable with a comma,
        and terminate each 10 with a 'return'. For example, for 17
        variables per line, enter first 10 values separating each by
        a comma, hit 'return', enter next 7 values separating each by
        a comma, hit 'return', then go to next record

Comments:

Keep a separate memo of the name, format, and record length for
use in stat-pack programs. This is not saved on the disc file.

To purge a data file from the disc, enter: PU, 'data file name';
PK, 2.

To store a data file on tape run the STORT program. The purge option
can be used to delete the data file from the disc.

```
RU,DA30
DATA30
CREATE A DATA FILE FOR INPUT TO STAT PKG.
 INPUT TO DATA FILE IS A 2-DIMENSIONAL ARRAY
MAXIMUM OF 30 VALUES ACROSS,    32767    VALUES DOWN
NO RECORD IS KEPT OF FILE ORGANIZATION
ENTER OUTPUT FILE NAME - UP TO 6 CHARACTERS
YEWT
  ENTER LENGTH OF RECORD :   FOR EXAMPLE
 IF YOUR FORMAT IS (15(5X,F10.4)) YOUR LENGTH WOULD BE
   15 * (5 + 10 ) =  225
180
  ENTER DESIRED OUTPUT FORMAT
(30(1X,F5.1))
ENTER # OF OBSERVATIONS ACROSS
30
 ENTER # OF LEVELS DOWN
3
ENTER DATA VALUES BY ROWS IN GROUPS OF 10
 VARIABLES, SEPARATE EACH DATA VALUE BY A COMMA
TERMINATE EACH 10 WITH CARRIAGE RETURN, IE :
IF YOU HAD 17 VARIABLES ENTER IN FIRST 10 , HIT 'RETURN'
THEN ENTER FINAL 7 AND HIT 'RETURN'

 ROW      1
1,2,3,4,5,6,7,8,9,10
11,12,13,14,15,16,17,18,19,20
21,22,23,24,25,26,27,28,29,30
 ROW      2
10,20,30,40,50,60,70,80,90,100
110,120,129,156,178,333,444,555,666,777
888,999,111,222,345,456,567,678,789,890
 ROW      3
15,25,35,45,55,65,75,85,95,105
29,39,49,59,99,109,76,35,33,22
11,22,33,44,55,66,77,88,99,0
 YOUR DATA FILE YEWT    IS NOW CREATED,
:
```

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```
0001  FTN4
0002        PROGRAM DA30
0003        DIMENSION ACROSS(100),NAMA(3),ID(272)
0004        DIMENSION IBUF(257),ISIZE(2),IFMT(20)
0005        WRITE(1,17)
0006  17    FORMAT(" DATA30 ",/," CREATS A DATA FILE FOR INPUT TO ",
0007       1"STAT PKG. ",/," INPUT TO DATA FILE IS A 2-DIMENSIONAL"
0008       2," ARRAY",/,"MAXIMUM OF 30 VALUES ACROSS, UNLIMITED  "
0009       3,"VALUES DOWN",/,"NO RECORD IS KEEP OF FILE ORGANIZATION",
0010       4/,"ENTER OUTPUT FILE NAME - UP TO 6 CHARACTERS")
0011        READ(1,18) NAMA
0012  18    FORMAT(3A2)
0013  234   FORMAT(20A2)
0014        WRITE(1,703)
0015  703   FORMAT(" ENTER LENGTH OF RECORD :  FOR EXAMPLE ")
0016  756   WRITE(1,705)
0017  705   FORMAT(" IF YOUR FORMAT IS (15(5X,F10.4)) YOUR LENGTH WOULD BE",
0018       1/,"   15 * (5 + 10 ) =  225")
0019        READ(1,*) LENGTH
0020        LEN=LENGTH/2
0021        IF((LEN*2).NE.LENGTH) LEN=LEN+1
0022        LENGTH=LEN
0023        IF(LEN.LE.256) GO TO 256
0024        WRITE(1,706)
0025  706   FORMAT( " LENGTH IS TOO LARGE, MAX IS 512")
0026        GO TO 756
0027  256   IDCBS=256
0028        ISIZE(2)=LENGTH
0029  120   WRITE(1,5358)
0030  5358  FORMAT("  ENTER DESIRED OUTPUT FORMAT")
0031        READ(1,234) IFMT
0032        WRITE(1,30)
0033  30    FORMAT( "ENTER # OF OBSERVATIONS ACROSS")
0034        READ(1,*) NLEV
0035        WRITE(1,31)
0036  31    FORMAT(" ENTER # OF LEVELS DOWN")
0037        READ(1,*) NGRPS
0038        SIZE=LENGTH
0039        XGRPS=NGRPS
0040        SIZE=XGRPS*SIZE/128. + 1.
0041        ISIZE(1)=SIZE
0042  755   CALL CREAT(ID,IERR,NAMA,ISIZE,2,0,-2,IDCBS)
0043        IF(IERR.GT.0) GO TO 100
0044        WRITE(1,13) IERR
0045  13    FORMAT(" ERROR # ",I5," AT CREATING FILE ")
0046        STOP 13
0047  100   CALL CLOSE(ID)
0048        CALL OPEN(ID,IER,NAMA)
0049        IF(IER.GE.0) GO TO 124
0050  52    WRITE(1,459) IER
0051  459   FORMAT(" FAILED TO OPEN , IER = ",I5)
0052        STOP 457
```

```
0053   124      IF(NLEV.GT.10) GO TO 666
0054            WRITE(1,32)
0055   32       FORMAT(" ENTER DATA VALUES BY ROW,SEPARATED WITH ",
0056            1"COMMAS",/," TERMINATE ROW WITH CARRIAGE RETURN")
0057            DO 41 J2=1,NGRPS
0058            DO 66 I=1,NLEV
0059   66       ACROSS(I)=0.0
0060            WRITE(1,42) J2
0061   42       FORMAT(" ROW ",I5)
0062            READ(1,*)(ACROSS(J3),J3=1,NLEV)
0063            CALL CODE
0064            WRITE(IBUF,IFMT)(ACROSS(J3),J3=1,NLEV)
0065            CALL WRITF(ID,IER,IBUF)
0066            IF(IER.GE.0) GO TO 41
0067            WRITE(1,44) IER
0068   44       FORMAT("ERROR # ",I5," AT FILE WRITING")
0069            CALL CLOSE(ID)
0070            STOP 44
0071   41       CONTINUE
0072            GO TO 555
0073   666      WRITE(1,777)
0074   777      FORMAT("ENTER DATA VALUES BY ROWS IN GROUPS OF 10",/
0075            $," VARIALBES, SEPERATE EACH DATA VALUE BY A COMMA",/,
0076            2"TERMINATE EACH 10 WITH CARRIAGE RETURN, IE ↑ ",/,
0077            &"IF YOU HAD 17 VARIALBES ENTER IN FIRST 10 , HIT 'RETURN'",
0078            1/"THEN ENTER FINAL 7  AND HIT 'RETURN'"/ )
0079            IH=(9+NLEV)/10
0080            DO 51 J2=1,NGRPS
0081            DO 67 I=1,NLEV
0082   67       ACROSS(I)=0.
0083            WRITE(1,42) J2
0084            DO 68 I=1,IH
0085            K=10* I
0086            L=(I-1)*10 + 1
0087   68       READ(1,*) (ACROSS(J3),J3=L,K )
0088            CALL CODE
0089            WRITE(IBUF,IFMT) (ACROSS(J3),J3=1,NLEV)
0090            CALL WRITF(ID,IER,IBUF)
0091            IF(IER.LT.0) GO TO 52
0092   51       CONTINUE
0093   555      WRITE(1,166) NAMA
0094   166      FORMAT(" YOUR DATA FILE ",3A2," IS NOW CREATED,",/,
0095            1" THIS PROGRAM IS FINISHED ")
0096            CALL CLOSE(ID)
0097            END
0098            END$
```

STORT (Data File Storage/Retrieval)

Purpose:

   This program performs either of two operations:

      Storage of data files onto tape (for backup purposes and/or
      permanent storage)
      Retrieval of data files stored on tape

User Considerations and Procedures:

   1. Data files transferred to tape will keep their same format and
       record length as on the disc. When tape files are retrieved, the
       data file can be renamed and stored on the disc.

   2. Option for storage or retrieval. Enter 1 for storage of data file
       onto tape, and 2 for retrieval of data file from tape to the disc.

   3. When option for storage onto tape is used, the program will ask if
       the data file is to be purged (deleted from the disc). Enter 1 for
       deletion, and 2 for keeping data file on disc.

   4. Parameters required:

       a. name of data file

           1) for storing data, this is the name of the disc data file
               to be transferred
           2) for retrieving a data file, this is the name of the disc
               file which the data will be transferred to

       b. tape file number

           1) for storing data, program asks for the next available tape
               file number where the data can be stored. Files are stored
               on tape sequentially
           2) to retrieve data, program asks for the number of the tape
               file to be returned to a disc file

```
RU,STORT
:SV,4
THIS PROGRAM STORES AND RETRIEVES DATA FILES CREATED
 BY DA30 AND TRAFM PROGRAMS ONTO TAPE FILES TO BE USED LATER.   NOW, MOUNT
 DATA TAPE AND ENTER 1 WHEN THROUGH
1
ENTER NAME OF DATA FILE
#FATAA
ENTER 1 FOR STORAGE ONTO TAPE, OR 2 FOR RETREIVAL
1
ENTER NEXT AVAILABLE FILE # ON TAPE
2
STORT FINISHED WHEN TAPE STOPS
ENTER 1 TO PURGE DATA FILE FROM DISC ELSE ENTER 0
0
:
```

```
0001    FTN4
0002            PROGRAM STOR
0003            DIMENSION IFMGR(3),INAME(3),IBUF1(6),IBUF2(6)
0004            DIMENSION IB(144),IBUF(144),NAME(3)
0005            DIMENSION IBUF3(6),ID(3)
0006            DATA IBUF3/2H:P,2HU,/
0007            DATA ID/2H:P,2HK,,2HO2/
0008            DATA NAME/2HST,2HOT,2HR /
0009            DATA IBUF1/2H:S,2HT,,2H8,/
0010            DATA IBUF2/2H:S,2HT,/
0011            DATA IC/2H.8/
0012            J1=13108
0013            CALL OPEN(IB,IER,NAME)
0014            WRITE(1,99)
0015            REWIND 8
0016    99      FORMAT("THIS PROGRAM STORES AND RETRIEVES DATA FILES CREATED ",
0017            $/," BY DA30 AND ",
0018            $"TRAFM PROGRAMS ONTO TAPE FILES TO BE USED LATER.  NOW, MOUNT",
0019            $/," DATA TAPE AND ENTER 1 WHEN THROUGH")
0020            READ(1,*) ITP
0021    60      IBUF2(6)=IC
0022            WRITE(1,1)
0023    1       FORMAT("ENTER NAME OF DATA FILE")
0024            READ(1,2) INAME
0025    2       FORMAT(3A2)
0026            WRITE(1,3)
0027    3       FORMAT("ENTER 1 FOR STORAGE ONTO TAPE, OR 2 FOR RETREIVAL")
0028            READ(1,*) IST
0029            IF(IST.EQ.1) GO TO 100
0030            WRITE(1,6)
0031    6       FORMAT("ENTER THE # OF THE FILE ON THE TAPE")
0032            READ(1,*) ITP
0033            IF(ITP.LE.1) GO TO 1040
0034            K=ITP-1
0035    1040    DO 10 I=1,3
0036    10      IBUF1(I+3)=INAME(I)
0037            CALL CODE
0038            WRITE(IBUF,23) IBUF1
0039            GO TO 20
0040    100     WRITE(1,50)
0041    50      FORMAT("ENTER NEXT AVAILABLE FILE # ON TAPE")
0042            READ(1,*) ITP
0043            IF(ITP.LE.1) GO TO 105
0044            K=ITP-1
0045    105     DO 21 I=1,3
0046    21      IBUF2(I+2)=INAME(I)
0047            CALL CODE
0048            WRITE(IBUF,23) IBUF2
0049    20      CONTINUE
0050    23      FORMAT(6A2)
0051            CALL WRITF(IB,IER,IBUF,6)
0052            WRITE(1,24)
0053    24      FORMAT("STORT FINISHED WHEN TAPE STOPS")
```

```
0054        IF(K.EQ.0) GO TO 34
0055        DO 104 J=1,K
0056   104  CALL EXEC(3,J1)
0057   34   CALL EXEC(13,10B,I1,I2,I3)
0058        IF(I1.LT.0) GO TO 34
0059        IF(IST.EQ.2) GO TO 70
0060        WRITE(1,51)
0061   51   FORMAT("ENTER 1 TO PURGE DATA FILE FROM DICS",
0062       $" ELSE ENTER 0")
0063        READ(1,*) ITEST
0064        IF(ITEST.NE.1) GO TO 70
0065        DO 52 J1=1,3
0066   52   IBUF3(J1+2)=INAME(J1)
0067        CALL CODE
0068        WRITE(IBUF,53) IBUF3
0069   53   FORMAT(5A2)
0070        CALL WRITF(IB,IER,IBUF,5)
0071        CALL CODE
0072        WRITE(IBUF,54) ID
0073   54   FORMAT(3A2)
0074        CALL WRITF(IB,IER,IBUF,3)
0075   70   CALL CLOSE(I9)
0076        END
0077        END$
```

EDIT (Data File Editor)

Purpose:

> This program is a simple editing program to modify values in data
> files with large record lengths (i.e., those with lengths > 80).
> The program will change values of variable (i), subject (j). The
> program will also list the original data and the revised data in
> any output format specified, if requested.

User Considerations and Procedures:

1. Program expects data in a row x column (R x C) matrix form.
   Each line of raw data would have C (column) elements (all
   variables for subject (j)).

2. A listing of the data file can be obtained before editing.
   Option: 1 if raw data printout is desired, 0 for no printout.
   A listing of the revised data can only be obtained by rerunning
   the program after the necessary modifications have been made.

3. Data listings can either be displayed on the CRT or a hard-
   copy can be obtained from the line printer. Option: 1 for
   CRT output, 6 for line printer output.

4. If the option for data listing is used, the program will ask
   for the desired output format. When the raw data have been
   listed, enter 1 to end EDIT or 0 to continue with editing.

5. For each editing change desired, enter record number, variable
   number, and desired correction separating each by commas. For
   example, to change variable 22 of subject 10 from 39.5 to 29.5,
   type 10, 22, 29.5. Continue with the same procedure for other
   corrections, if any. When there are no more corrections to be
   made, type -999 -999 -999.

6. Parameters required:

   a. number of variables (maximum 100)

   b. number of subjects (maximum 32767)

   c. name of data file

   d. format and record length of file (see DA30)

   e. format used to list data (for legibility of data files)

   f. editing parameters and corrections

```
  RU,EDIT
ENTER NAME OF DATA FILE
#FATAA
ENTER FORMAT OF DATA
(8(2X,F6.2))
ENTER NUMBER OF VARIABLES
8
ENTER NUMBER OF SUBJECTS(RECORDS)
32
 ENTER THE RECORD LENGTH AS IN DA30
64
 ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
1
ENTER 1 FOR DATA LISTING
0
ENTER IN ORDER 'RECORD #,VARIABLE #, CORRECTION
 !E,  TO CHANGE THE VALUE OF VARIABLE 5 OF SUBJECT 10
 TO 29.5 TYPE
          10,5,29.5
WHEN YOU ARE THROUGH WITH ALL CORRECTIONS TYPE IN
          -999,-999,-999
3,5,678.1
5,8,599.9
15,6,435.12
24,1,39.5
31,2,45.6
-999,-999,-999
EDITING FINISHED
:
```

```
0001   FTN4,L
0002          PROGRAM EDIT
0003          COMMON IB(272),IBUF(256),INAmE(3),IFMT1(20),IFMT2(20),X(100)
0004          WRITE(1,1)
0005   1      FORMAT("ENTER NAME OF DATA FILE")
0006          READ(1,2) INAME
0007   2      FORMAT(3A2)
0008          WRITE(1,3)
0009   3      FORMAT("ENTER FORMAT OF DATA")
0010          READ(1,4) IFMT1
0011   4      FORMAT(20A2)
0012          WRITE(1,13)
0013   13     FORMAT("ENTER NUMBER OF VARIABLES")
0014          READ(1,*) NVAR
0015          WRITE(1,11)
0016   11     FORMAT("ENTER NUMBER OF SUBJECTS(RECORDS)")
0017          READ(1,*) NSUB
0018          WRITE(1,88)
0019   88     FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0020          READ(1,*) LENGTH
0021          LEN=LENGTH/2
0022          IF((LEN*2).NE.LENGTH) LEN=LEN+1
0023          LENGTH=LEN
0024          IDCBS=LENGTH
0025          IF(LENGTH.LT.144) IDCBS=144
0026          CALL OPEN(IB,IER,INAME,3,0,-2,IDCBS)
0027          IF(IER.GE.0) GO TO 100
0028          WRITE(1,5) INAME,IER
0029   5      FORMAT(3A2,"  FAILED TO OPEN , IER = ",I5)
0030          STOP 5
0031   100    WRITE(1,6)
0032   6      FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
0033          READ(1,*) IUNIT
0034          WRITE(1,7)
0035   7      FORMAT("ENTER 1 FOR DATA LISTING")
0036          READ(1,*) ICON
0037          IF(ICON.NE.1) GO TO 1100
0038   10     FORMAT("ENTER OUTPUT FORMAT DISIRED")
0039   1000   WRITE(1,10)
0040          READ(1,4) IFMT2
0041          DO 1012 J=1,NSUB
0042          CALL READF(IB,IER,IBUF)
0043          CALL CODE
0044          READ(IBUF,IFMT1)(X(I),I=1,NVAR)
0045          WRITE(IUNIT,133)
0046   133    FORMAT(5X)
0047   1012   WRITE(IUNIT,IFMT2) (X(I),I=1,NVAR)
0048          WRITE(1,17)
0049   17     FORMAT("ENTER ONE TO END EDIT")
0050          READ(1,*) ICON
0051          IF(ICON.EQ.1) STOP 17
```

16

```
0052    1100    WRITE(1,18)
0053    18      FORMAT("ENTER IN ORDER 'RECORD #,VARIALBE #, CORRECTION",/
0054            $"IE,   TO CHANGE THE VALUE OF VARIABLE 5 OF SUBJECT 10",/
0055            %" TO 29.5 TYPE",/,10X," 10,5,29.5",/,"WHEN YOU ARE THROUGH",
0056            #" WITH ALL CORRECTIONS TYPE IN ",/,10X,"-999,-999,-999")
0057            DO 1111 J=1,10000
0058            READ(1,*) K,L,Z
0059            IF(K.EQ.-999) GO TO 999
0060            CALL READF(IB,IER,IBUF,IDCBS,LEN,K)
0061            CALL CODE
0062            READ(IBUF,IFMT1) (X(I),I=1,NVAR)
0063            X(L)=Z
0064            CALL CODE
0065            WRITE(IBUF,IFMT1) (X(I),I=1,NVAR)
0066            CALL WRITF(IB,IER,IBUF,0,-1)
0067            CALL RWNDF(IB)
0068    1111    CONTINUE
0069    999     WRITE(1,16)
0070    16      FORMAT("EDITING FINISHED")
0071            END
0072            END$
```

TRAFM   (Data Transformation)

Purpose:

    This program is used to create a new data set based on a transformation of an old data set. TRAFM can transform data that are in matrix form or in sequential (continuous) form. The program performs the following 11 transformations:

    1 = reciprocal $(1/x)$
    2 = square root
    3 = $\log_{10}$
    4 = Z score $\dfrac{x - mean}{SD}$ using mean and standard deviation of all desired variables
    5 = $\frac{1}{2} \log_{10} (1 + x)/(1 - x)$
    6 = x + constant
    7 = x - constant
    8 = x * constant
    9 = x / constant
    10 = 2 arcsin $(x^{**}.5)$ = 2 arcsin $\sqrt{x}$
    11 = Z score by individual means and standard deviations

User Considerations and Procedures:

1. Program creates a new data file. Caution should be taken to format the new data to correspond to the requested transformation. For example, reciprocal data will require decimal notation.

2. Program needs to know the type of data file which will be used. Enter 1 if data are in sequential form, enter 0 if in matrix form.

3. For data in matrix form:

    a. program asks for number of subjects twice. Respond both times with the number of rows in the matrix file

    b. program asks for number of variables per subjec (columns). Respond with the number of columns in the matrix file (maximum 30)

    c. program asks if the same transformation is desired for all variables. Respond 1 for yes, 0 for no

    d. if a 0 response was given to the above (c), program asks for the variable number (column) that is to be transformed. Then, program asks if more transformations are desired. Respond 1 for yes, or 0 for no. On a response of 1, the sequence is repeated

4. For data in a sequential form: (program expects data to index
    for subjects first, then for variables, with one subject per line).

    a. program asks for number of subjects in TRAFM file; respond
        with the total number of records in the data file

    b. program asks for number of variables in data file. This allows
        some leeway in breaking up or partitioning the transform file.
        If there is no logical way to partition the file, enter 1 for
        only one variable. In most cases, number of variables is the
        number of groups of subjects

    c. same as 3-c

    d. same as 3-d

    e. programs ask for number of subjects for each variable. Respo
        with the number of subjects in each group

5. Parameters required:

    a. type of transform required. Enter the numberical code which
        corresponds to the correct transformation. When the transfor-
        mation is finished, enter 0 to end the program, or enter 1 to
        perform another transformation.

    b. name of old file

    c. name of new TRAFM file

    d. format and record length of old data file (see DA30)

    e. format and record length of new data file (see DA30)

    f. other parameters required for certain transformation such as
        largetst positive number of constant to be used. For more
        information, see comments

6. There is no printout of the original or transformed data.

Comments:

    Uses and special considerations for each transformation.

    1. Reciprocal

        This is used to normalize data when the raw data are skewed to the
        right. If a raw value is 0, the program arbitrarily assigns a value
        of 1. This transformation improves homoscedasticity of the distribution.

2. Square Root

   This is used to normalize rightly skewed data. Program asks
   for the largest negative number in absolute value (C). The
   actual transformation is SQRT (x + C) when x is less than or
   equal to ten. This transformation improves the homoscedasticity
   of the distribution.

3. Log_{10}

   This is the strongest transformation to normalize rightly skewed
   data. It may pull in the right tail too far and create outliers
   on the left side of the distribution. When this occurs, trans-
   formation 1 or 2 above is warranted. Program requires that the
   largest negative number in absolute value (C) be inputed. The
   actual transformation is log (x + C + 1). The log transform is
   the most powerful in improving homoscedasticity and can be used
   solely for this purpose.

4. Z Score

   This transformation can be performed by using the mean and standard
   deviation of all the variables in the data file or by the mean and
   standard deviation of the specific variable (column) to be trans-
   formed. Respond 1 if the transform should be based on all data,
   or 0 if calculations are to be based on only the specified trans-
   form variable.

5. $\frac{1}{2} Log ((1 + x)/(1 - x))$

   This is used to transform left skewed distributions or platykurtic
   distributions. Program requires highest positive number (C) to
   be given and the highest negative number in absolute value (C_2).
   The actual transformation is:

   $\frac{1}{2} Log ((1 + x')/(1 - x'))$, where $x' = (x + C_2)/(C_2 + C + 1)$.

6. x + Constant

   This transformation is used to move distribution right or left
   to rescale the data values. Program asks for the required constant.

7. x - Constant

   This transformation is used to move distribution right or left to
   rescale the data values. Program asks for the required constant.

8. x * Constant

   This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

9. x / Constant

   This transformation is used to move distribution right or left to rescale the data values. Program asks for the required constant.

10. 2 arcsin $\sqrt{x}$

    This transformation is applicable for left-skewed distributions or playtkurtic distributions. Data must be proportional data; i.e., $0 \leqslant x \leqslant 1$. This transformation is useful in many non-parametric procedures.

11. Individual Z Score

    This transformation is done by standardization of desired variables by their individual means and standard deviations.

Test Data:

   Program was tested by comparing data output with calculator analysis and the Statistical Analysis System. Transformation involving logs or sines are accurate to five digits; other transformations are accurate to six digits.

```
RU,TRAFM


  PROGRAM TO TRANSFORM DATA


TYPE OF TRANSFORM
Ø = STOP
1 = RECIPICAL 1/X
2 = SQUARE ROOT (X)**.5
3 = LOG(1Ø)X
4 = Z SCORE=(X-MEAN)/SD
5 = 1/2 LOG ((1+X)/(1-X))
6 = X + CONSTANT
7 = X - CONSTANT
8 = X * CONSTANT
9 = X / CONSTANT
1Ø = 2 ARCSIN (X**.5) - MUST BE PROPORTIONAL DATA<15>
11 = Z SCORE BY INDIVIDUAL VARIABLE MEAN AND SD
ENTER BY NUMBER THE TRANSFORMED DESIRED:
11
 DATA FILENAME
#FATAA
 DATA FORMAT
(8(2X,F6.2))
 NEW DATA FILENAME
#ZSCR
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
  INPUT NUMBER OF SUBJECTS IN TRAFM FILE
32
 NUMBER OF VARIABLES PER SUBJECT :
8
 DO YOU WISH TRANSFORMATIONS ON ALL VARIABLES, 1 = YES , Ø - NO
1
 TYPE OF DATA FILE 1 = CONTINUOUS , Ø = MATRIX :
Ø
 NUMBER OF SUBJECTS :
32
 TRANSFORMATION TYPE    11  IS FINISHED
 TO STOP ENTER Ø, FOR MORE ENTER ANY OTHER NUMBER
Ø
  TRAFM : STOP    ØØØØ
:
```

```
0001   FTN4
0002          PROGRAM TRAFM
0003          DIMENSION NAME(3),INAME(3),IFMT(20),IDATA(30),DTA(30),IZ(30)
0004          DIMENSION IB(272),IC(272),IBUF(256),ICUF(256),ISIZE(2)
0005          DIMENSION SUM1(30),SUM3(30),XBR(30),STD(30)
0006          DIMENSION IFMT1(20)
0007   50     WRITE(1,277)
0008   277    FORMAT(//,"   PROGRAM  TO  TRANSFORM  DATA ",//,/,
0009          C" TYPE OF TRANSFORM"  ,/,
0010          C" 0 = STOP"  ,/,
0011          C" 1 = RECIPICAL 1/X" ,/,
0012          C" 2 = SQUARE ROOT (X,/,**.5" ,/,
0013          C" 3 = LOG(10)X"  )
0014          WRITE(1,4405)
0015   4405   FORMAT ( " 4 = Z SCORE (X-MEAN)/SD" ,/,
0016          C" 5 = 1/2 LOG ((1+X)/(1-X))",/,
0017          C" 6 = X + CONSTANT"  ,/,
0018          C" 7 = X - CONSTANT"  ,/,
0019          C" 8 = X * CONSTANT"  ,/,
0020          C" 9 = X / CONSTANT"  )
0021          WRITE(1,4411)
0022   4411   FORMAT ("10 = 2 ARCSIN (X**.5) - MUST BE PROPORTIONAL DATA(15)"
0023          C,/," 11 = Z SCORE BY INDIVIDUAL VARIABLE MEAN AND SD",/,
0024          C" ENTER BY NUMBER THE TRANSFORMED DESIRED:  ")
0025          READ(1,*) ITEST
0026          IF(ITEST.EQ.0)GO TO 61
0027          WRITE(1,4413)
0028   4413   FORMAT ("ENTER INPUT DATA FILENAME" )
0029          READ(1,30)NAME
0030   30     FORMAT(3A2)
0031          WRITE(1,4414)
0032   4414   FORMAT ( " DATA FORMAT" )
0033          READ(1,130)IFMT
0034   130    FORMAT(20A2)
0035          WRITE(1,4238)
0036   4238   FORMAT("ENTER THE INPUT RECORD LENGTH AS IN DA30")
0037          READ(1,*)LENGTH
0038          WRITE(1,4415)
0039   4415   FORMAT ( " NEW DATA FILENAME" )
0040          READ(1,30)INAME
0041          WRITE(1,4673)
0042   4673   FORMAT("ENTER OUTPUT DATA FORMAT")
0043          READ(1,130) IFMT1
0044          IDCBS=256
0045          ISIZE(1)=-1
0046          ISIZE(2)=LENGTH
0047          CALL CREAT(IC,IER1,INAME,ISIZE,2,0,-2,IDCBS)
0048          IF(IER1.GE.0) GO TO 379
0049          WRITE(1,981)
0050   981    FORMAT("  INPUT NUMBER OF SUBJECTS IN TRAFM FILE")
```

```
0051        READ(1,*) NSU
0052        SIZE=LENGTH
0053        XNSU=NSU
0054        SIZE=XNSU*SIZE/128. + 1.
0055        ISIZE(1)=SIZE
0056        CALL CREAT(IC,IER,IHAME,ISIZE,2,0,-2,IDCBS)
0057        IF(IER.GE.0) GO TO 379
0058   879  WRITE(1,378) IHAME,IER
0059        CALL CLOSE(IB)
0060        STOP 3715
0061   379  K4=0
0062        CALL OPEN(IB,IERR,HAME,3,0,-2,IDCBS)
0063        IF(IERR.GE.0) GO TO 377
0064        WRITE(1,378) HAME,IERR
0065   378  FORMAT(1X,3A2," FAILED TO OPEN, ERROR # ",I5)
0066        CALL PURGE(IC,IER,IHAME)
0067        STOP 371
0068   377  WRITE(1,4416)
0069  4416  FORMAT ( " NUMBER OF VARIABLES PER SUBJECT :   ")
0070        READ(1,*)  IV
0071        WRITE(1,4417)
0072  4417  FORMAT(" DO YOU WISH TRANSFORMATIONS ON ALL VARIABLES,"
0073       1," 1 = YES , 0 - NO ")
0074        READ(1,*)  IFT
0075        IF(IFT.EQ.0)GO TO 20
0076        DO 19 K=1,IV
0077    19  IDATA(K)=1
0078        GO TO 31
0079    20  DO 21 K=1,IV
0080    21  IDATA(K)=0
0081    22  WRITE(1,4418)
0082  4418  FORMAT ( " TRANSFORM ON VARIABLE #   ")
0083        READ(1,*) ITRN
0084        IDATA(ITRN)=1
0085        WRITE(1,4419)
0086  4419  FORMAT ( " ANY MORE TRANSFORMS 1 = YES , 0 = NO  ")
0087        READ(1,*)  ITRN
0088        IF(ITRN.EQ.1)GO TO 22
0089    31  WRITE(1,4420)
0090  4420  FORMAT ( " TYPE OF DATA FILE 1 = CONTINIOUS , 0 = MATRIX :   ")
0091        READ(1,*) IFLE
0092        IF(IFLE.EQ.1.AND.ITEST.EQ.11) GO TO 11
0093        IF(IFLE.EQ.1)GO TO 32
0094        WRITE(1,4421)
0095  4421  FORMAT ( " NUMBER OF SUBJECTS     ")
0096        READ(1,*) NSUB
0097        IDPT=IV
0098        IV=0
0099        GO TO 33
0100    32  K4=K4+1
0101        WRITE(1,4422) K4
0102  4422  FORMAT ( " NUMBER OF SUBJECTS FOR VARIABLE #  ",I5  )
0103        READ(1,*) NSUB
0104        IDPT=1
0105    33  GO TO (1,2,3,4,5,6,7,8,9,10,11)ITEST
```

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```
0106   1      DO 100 K=1,NSUB
0107          CALL READF(IB,IER,IBUF)
0108          CALL CODE
0109          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0110          IF(K4.EQ.0)GO TO 102
0111          J=K4
0112          GO TO 103
0113   102    DO 101 J=1,IDPT
0114   103    IF(IDATA(J).EQ.0)GO TO 101
0115          IF(K4.NE.0)J=1
0116          IF(DTA(J).EQ.0)DTA(J)=DTA(J)+1
0117          DTA(J)=1/DTA(J)
0118   101    CONTINUE
0119          CALL CODE
0120          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0121          CALL WRITF(IC,IE,ICUF)
0122   100    CONTINUE
0123          GO TO 60
0124   2      WRITE(1,4423)
0125   4423   FORMAT (" ENTER THE LARGEST NEG. VALUE AS AN ABSOL. NUMBER:")
0126          READ(1,*) C
0127          DO 200 K=1,NSUB
0128          CALL READF(IB,IE,IBUF)
0129          CALL CODE
0130          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0131          IF(K4.EQ.0)GO TO 202
0132          J=K4
0133          GO TO 203
0134   202    DO 201 J=1,IDPT
0135   203    IF(IDATA(J).EQ.0)GO TO 201
0136          IF(K4.NE.0)J=1
0137          IF(DTA(J).LT.10)DTA(J)=DTA(J)+.5+C
0138          DTA(J)=(DTA(J)**.5)
0139   201    CONTINUE
0140          CALL CODE
0141          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0142          CALL WRITF(IC,IE,ICUF)
0143   200    CONTINUE
0144          GO TO 60
0145   3      WRITE(1,4424)
0146   4424   FORMAT (  " ENTER LARGEST NEG. NUMBER AS AN ABSOL. NUMBER :   ")
0147          READ(1,*)  C
0148          DO 300 K=1,NSUB
0149          CALL READF(IB,IER,IBUF)
0150          CALL CODE
0151          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0152          IF(K4.EQ.0)GO TO 302
0153          J=K4
0154          GO TO 303
0155   302    DO 301 J=1,IDPT
0156   303    IF(IDATA(J).EQ.0)GO TO 301
0157          IF(K4.NE.0)J=1
0158          DTA(J)=ALOG(DTA(J)+1+C)
0159   301    CONTINUE
```

```
0160          CALL CODE
0161          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0162          CALL WRITF(IC,IE,ICUF)
0163   300    CONTINUE
0164          GO TO 60
0165   5      WRITE(1,4425)
0166   4425   FORMAT ( " TYPE THE HIGHEST POSITIVE NUMBER :   ")
0167          READ(1,*)  C
0168          WRITE(1,4426)
0169   4426   FORMAT ( " TYPE THE HIGHEST NEG. # AS AN ABSOL. NUMBER :   ")
0170          READ(1,*)   C1
0171          DO 500 K=1,NSUB
0172          CALL READF(IB,IRT,IBUF)
0173          CALL CODE
0174          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0175          IF(K4.EQ.0)GO TO 502
0176          J=K4
0177          GO TO 503
0178   502    DO 501 J=1,IDPT
0179   503    IF(IDATA(J).EQ.0)GO TO 501
0180          IF(K4.NE.0)J=1
0181          DTA(J)=(DTA(J)+C1)/(C+C1+1)
0182          DTA(J)=(ALOG((1+DTA(J))/(1-DTA(J))))*.5
0183   501    CONTINUE
0184          CALL CODE
0185          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0186          CALL WRITF(IC,IEV,ICUF)
0187   500    CONTINUE
0188          GO TO 60
0189   6      WRITE(1,4427)
0190   4427   FORMAT ( " TYPE CONSTANT TO BE USED :   ")
0191          READ(1,*)  C
0192          DO 600 K=1,NSUB
0193          CALL READF(IB,IER,IBUF)
0194          CALL CODE
0195          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0196          IF(K4.EQ.0)GO TO 602
0197          J=K4
0198          GO TO 603
0199   602    DO 601 J=1,IDPT
0200   603    IF(IDATA(J).EQ.0)GO TO 601
0201          IF(K4.NE.0)J=1
0202          DTA(J)=DTA(J)+C
0203   601    CONTINUE
0204          CALL CODE
0205          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0206          CALL WRITF(IC,IER,ICUF)
0207   600    CONTINUE
0208          GO TO 60
0209   7      WRITE(1,4428)
0210   4428   FORMAT ( " TYPE CONSTANT TO BE USED :   ")
0211          READ(1,*)  C
0212          DO 700 K=1,NSUB
0213          CALL READF(IB,IER,IBUF)
0214          CALL CODE
```

```
0215          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0216          IF(K4.EQ.0)GO TO 702
0217          J=K4
0218          GO TO 703
0219   702    DO 701 J=1,IDPT
0220   703    IF(IDATA(J).EQ.0)GO TO 701
0221          IF(K4.NE.0)J=1
0222          DTA(J)=DTA(J)-C
0223   701    CONTINUE
0224          CALL CODE
0225          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0226          CALL WRITF(IC,IER,ICUF)
0227   700    CONTINUE
0228          GO TO 60
0229   8      WRITE(1,4429)
0230   4429   FORMAT (  " TYPE CONSTANT TO BE USED :    ")
0231          READ(1,*)  C
0232          DO 800 K=1,NSUB
0233          CALL READF(IB,IER,IBUF)
0234          CALL CODE
0235          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0236          IF(K4.EQ.0)GO TO 802
0237          J=K4
0238          GO TO 803
0239   802    DO 801 J=1,IDPT
0240   803    IF(IDATA(J).EQ.0)GO TO 801
0241          IF(K4.NE.0)J=1
0242          DTA(J)=DTA(J)*C
0243   801    CONTINUE
0244          CALL CODE
0245          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0246          CALL WRITF(IC,IER,ICUF)
0247   800    CONTINUE
0248          GO TO 60
0249   9      WRITE(1,960)
0250   960    FORMAT( " TYPE CONSTANT TO BE USED :    ")
0251          READ(1,*) C
0252          DO 900 K=1,NSUB
0253          CALL READF(IB,IER,IBUF)
0254          CALL CODE
0255          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0256          IF(K4.EQ.0)GO TO 902
0257          J=K4
0258          GO TO 903
0259   902    DO 901 J=1,IDPT
0260   903    IF(IDATA(J).EQ.0)GO TO 901
0261          IF(K4.NE.0)J=1
0262          DTA(J)=DTA(J)/C
0263   901    CONTINUE
0264          CALL CODE
0265          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0266          CALL WRITF(IC,IER,ICUF)
0267   900    CONTINUE
0268          GO TO 60
0269   10     DO 1000 K=1,NSUB
0270          CALL READF(IB,IER,IBUF)
0271          CALL CODE
```

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```
0272        READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0273        IF(K4.EQ.0)GO TO 1002
0274        J=K4
0275        GO TO 1003
0276   1002 DO 1001 J=1,IDPT
0277   1003 IF(IDATA(J).EQ.0)GO TO 1001
0278        IF(K4.NE.0)J=1
0279        IF(DTA(J).LE.0.OR.DTA(J).GE.1)GO TO 1010
0280        DTA(J)=2*ATAN((DTA(J)/(1-DTA(J)))**.5)
0281   1001 CONTINUE
0282        CALL CODE
0283        WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0284        CALL WRITF(IC,IER,ICUF)
0285   1000 CONTINUE
0286        GO TO 60
0287   1010 WRITE(1,951)
0288   951  FORMAT(" DATA MUST BE PROPORTIONAL - RECHECK DATA !!!",  ,"
0289        1TRANSFORM ABORTED ")
0290        GO TO 62
0291   4    IF(IFLE.EQ.0)GO TO 450
0292        IF(IFLE.GT.1)GO TO 420
0293   450  N=0
0294        SUM=0
0295        SUM2=0
0296        WRITE(1,950)
0297   950  FORMAT(" DO YOU WANT THE MEAN CALCUL.  ON ALL DATA POINTS ?",
0298        1/" 1 = YES , 0 = NO ")
0299        READ (1,*) C
0300   420  DO 400 K=1,NSUB
0301        CALL READF(IB,IER,IBUF)
0302        CALL CODE
0303        READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0304        IF(C.EQ.0)GO TO 401
0305        DO 402 J=1,IDPT
0306        N=N+1
0307        SUM=SUM+DTA(J)
0308        SUM2=SUM2+DTA(J)**2
0309   402  CONTINUE
0310        GO TO 400
0311   401  IF(K4.EQ.0)GO TO 421
0312        J=K4
0313        GO TO 422
0314   421  DO 400 J=1,IDPT
0315   422  IF(IDATA(J).EQ.0)GO TO 400
0316        IF(K4.NE.0)J=1
0317        N=N+1
0318        SUM=SUM+DTA(J)
0319        SUM2=SUM2+DTA(J)**2
0320   400  CONTINUE
0321        IF(IFLE.EQ.0)GO TO 423
0322        IFLE=IFLE+1
0323        IZ(K4)=NSUB
0324        IF(IFLE.GT.IY)GO TO 423
0325        GO TO 32
```

```
0326   423    XN=N
0327          XMEAN=SUM/XN
0328          SD=SQRT((SUM2-SUM*SUM/XN)/(XN-1.))
0329          CALL RWNDF(IB)
0330          IX=IV
0331          IV=0
0332          K1=0
0333          IF(IFLE.EQ.0)GO TO 431
0334          DO 410 K1=1,IX
0335          NSUB=IZ(K1)
0336   431    DO 410 K=1,NSUB
0337          CALL READF(IB,IER,IBUF)
0338          CALL CODE
0339          READ(IBUF,IFMT)(DTA(J),J=1,IDPT)
0340          IF(IFLE.EQ.0)GO TO 433
0341          J=K1
0342          GO TO 432
0343   433    DO 411 J=1,IDPT
0344   432    IF(IDATA(J).EQ.0)GO TO 411
0345          IF(IFLE.NE 0)J=1
0346          DTA(J)=(DTA(J)-XMEAN)/SD
0347   411    CONTINUE
0348          CALL CODE
0349          WRITE(ICUF,IFMT1)(DTA(J),J=1,IDPT)
0350          CALL WRITF(IC,IER,ICUF)
0351   410    CONTINUE
0352          GO TO 60
0353   11     IV=IDPT
0354          NSUB=NSU
0355          IF(IFLE.NE.1) GO TO 63
0356          N=0
0357          DO 3256 I=1,IV
0358          SUM=0.
0359          SUM2=0.
0360          WRITE(1,4422) I
0361          READ(1,*) NSUB
0362          DO 1027 J=1,NSUB
0363          N=N+1
0364          CALL READF(IB,IER,IBUF,256,LEN,N)
0365          CALL CODE
0366          READ(IBUF,IFMT) DAT
0367          SUM=SUM+DAT
0368          SUM2=SUM2+DAT*DAT
0369   1027   CONTINUE
0370          XSUB=NSUB
0371          XBAR=SUM/XSUB
0372          SD=SQRT((SUM2-SUM*SUM/XSUB)/(XSUB-1.))
0373          CALL RWNDF(IB)
0374          DO 1034 J=1,NSUB
0375          N=N-NSUB+J
0376          CALL READF(IB,IER,IBUF)
0377          CALL CODE
0378          READ(IBUF,IFMT) DAT
0379          IF(IDATA(I).EQ.0) GO TO 9651
0380          DAT=(DAT-XBAR)/SD
0381   9651   CALL CODE
```

```
0382          WRITE(ICUF,IFMT1) DAT
0383          M=N-NSUB+J
0384          CALL WRITF(IC,IER,ICUF,0,M)
0385   1034   CONTINUE
0386   3256   CONTINUE
0387          GO TO 62
0388   63     XSUB=NSUB
0389          DO 64 I=1,IV
0390          SUM1(I)=0.
0391   64     SUM3(I)=0.
0392          DO 65 I=1,NSUB
0393          CALL READF(IB,IER,IBUF)
0394          CALL CODE
0395          READ(IBUF,IFMT) (DTA(J),J=1,IV)
0396          DO 66 J=1,IV
0397          SUM1(J)=SUM1(J)+DTA(J)
0398          SUM3(J)=SUM3(J)+DTA(J)*DTA(J)
0399   66     CONTINUE
0400    65    CONTINUE
0401          DO 67 J=1,IV
0402          XBR(J)=SUM1(J)/XSUB
0403   67     STD(J)=SQRT((SUM3(J)-SUM1(J)*SUM1(J)/XSUB)/(XSUB-1.))
0404          CALL RWNDF(IB)
0405          DO 68 I=1,NSUB
0406          CALL READF(IB,IER,IBUF)
0407          CALL CODE
0408          READ(IBUF,IFMT) (DTA(J1),J1=1,IV)
0409          DO 69 J=1,IV
0410          IF(IDATA(J).EQ.0) GO TO 69
0411          DTA(J)=(DTA(J)-XBR(J))/STD(J)
0412   69     CONTINUE
0413          CALL CODE
0414          WRITE(ICUF,IFMT1) (DTA(J),J=1,IV)
0415          CALL WRITF(IC,IER,ICUF,0,I)
0416   68     CONTINUE
0417          GO TO 62
0418   60     IV=IV-1
0419          IF(IV.GT.0)GO TO 32
0420   62     CALL CLOSE (IB,IER)
0421          CALL CLOSE(IC)
0422          WRITE(1,4567) ITEST
0423   4567   FORMAT(" TRANSFORMATION TYPE ",I5,"  IS FINISHED",/,
0424          1" TO STOP ENTER 0, FOR MORE ENTER ANY OTHER NUMBER")
0425          READ(1,*) LTEST
0426          IF(LTEST.EQ.0) GO TO 61
0427          GO TO 50
0428   61     STOP
0429          END
0430          END$
```

II. PARAMETRIC STATISTICS

A. Descriptive Statistics

DSPD (Parametric Descriptive Statistics)

Purpose:

    This program describes parametric data by various statistics including mean, standard deviation, skewness, kurtosis, and range.

User Consideration and Procedures:

1. Data files can either be in matrix form with equal number of variables per subject, or in sequential form, n_j, where n_j equals number of subjects for variables j.

2. For data files in matrix form, the variables per subject constitute a record in the data file. A printout of raw data would show j observations per line (subject). For data files in sequential form, read in all subjects under variable 1, then index to variable 2, etc. Raw data printout shows 1 observation per line.

3. The data can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

4. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#3).

5. Parameters required:

    a. number of variables (maximum 30)

    b. data file name

    c. format and record length of data file

    d. type of data:

       1 for continuous (sequential)
       0 for matrix

    e. for continuous data file - number of subjects for each variable

    f. for matrix data file - number of subjects

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6. Printout gives the following information for each variable:

    a. variable number

    b. number of subjects

    c. mean

    d. standard deviation

    e. skewness

    f. kurtosis

    g. range

Test Data:

Program was tested by comparing data output with results obtained
from hardwired programmed functions of a Texas Instruments calculator.

```
 RU,DS?D
 NUMBER OF VARIABLES :
8
 INPUT FILENAME
#FATAA
ENTER DATA FORMAT
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN ?A3D
64
 TYPE OF DATA  1  =  CONTINUOUS , Ø = MATRIX:
Ø
ENTER # OF SUBJECTS
32
 ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT
6
:
```

```
VARIABLE #                          1
NUMBER OF SUBJECTS =               32
MEAN =                            42.750
STANDARD DEVIATION =              21.691
SKEWNESS =                          .581
KURTOSIS =                        -1.204
RANGE =                           63.000


VARIABLE #                          2
NUMBER OF SUBJECTS =               32
MEAN =                            48.812
STANDARD DEVIATION =              23.952
SKEWNESS =                         -.170
KURTOSIS =                        -1.384
RANGE =                           75.000


VARIABLE #                          3
NUMBER OF SUBJECTS =               32
MEAN =                           342.375
STANDARD DEVIATION =             380.971
SKEWNESS =                         1.160
KURTOSIS =                          .247
RANGE =                         1406.000


VARIABLE #                          4
NUMBER OF SUBJECTS =               32
MEAN =                           632.781
STANDARD DEVIATION =             464.372
SKEWNESS =                         1.544
KURTOSIS =                         2.590
RANGE =                         2122.000


VARIABLE #                          5
NUMBER OF SUBJECTS =               32
MEAN =                           616.656
STANDARD DEVIATION =             429.506
SKEWNESS =                         1.114
KURTOSIS =                          .767
RANGE =                         1730.00
```

```
VARIABLE #                          6
NUMBER OF SUBJECTS =                32
MEAN =                              672.687
STANDARD DEVIATION =                543.445
SKEWNESS =                          1.776
KURTOSIS =                          3.491
RANGE -                             2567.000


VARIABLE #                          7
NUMBER OF SUBJECTS =                32
MEAN =                              565.875
STANDARD DEVIATION =                376.128
SKEWNESS =                          .354
KURTOSIS =                          -1.256
RANGE =                             1264.000


VARIABLE #                          8
NUMBER OF SUBJECTS =                32
MEAN =                              601.625
STANDARD DEVIATION =                646.360
SKEWNESS =                          2.235
KURTOSIS =                          5.985
RANGE =                             3149.000
```

```
0001  FTN4
0002        PROGRAM DSPD
0003        DIMENSION NAME(3)
0004        DOUBLE PRECISION DAT(30),SUM(30),SUM2(30),SUM3(30),
0005       XSUM4(30),SMEAN(30),SKEW(30),AKURT(30),SD(30),RH(30),RL(30)
0006        DIMENSION IB(272),IBUF(256),IFMT(20),NS(30)
0007        WRITE(1,4400)
0008  4400  FORMAT ( " NUMBER OF VARIABLES :   ")
0009        READ(1,*) NV
0010        WRITE(1,4401)
0011  4401  FORMAT ( " INPUT FILENAME"  )
0012        READ(1,1)NAME
0013  1     FORMAT(3A2)
0014        WRITE(1,3458)
0015  3458  FORMAT(" ENTER DATA FORMAT ")
0016        READ(1,987) IFMT
0017  987   FORMAT(20A2)
0018        CALL OPEN(IB,IERR,NAME)
0019        IF(IERR.GE.0) GO TO 77
0020        WRITE(1,78) NAMA,IERR
0021  78    FORMAT(5X,3A2," FAILED TO OPEN ",I5," ERROR #")
0022        STOP
0023  77    WRITE(1,4403)
0024  4403  FORMAT ( " TYPE OF DATA  1 = CONTINIOUS , 0 = MATRIX :   ")
0025        READ(1,*) ITYP
0026        IF(ITYP.NE.0) GO TO 99
0027        WRITE(1,100)
0028  100   FORMAT( "ENTER # OF SUBJECTS ")
0029        READ(1,*) NSUB
0030        GO TO 20
0031  99    K4=NV
0032        IF(ITYP.EQ.0)GO TO 20
0033        K4=NV
0034        NV=1
0035        DO 3 J1=1,K4
0036        WRITE(1,4404) J1
0037  4404  FORMAT ( " NUMBER OF SUBJECTS FOR VARIABLE #  ",I5 )
0038        READ(1,*) NSUB
0039  20    DO 2 K=1,NSUB
0040        CALL READF(IB,IER,IBUF)
0041        CALL CODE
0042        READ(IBUF,IFMT)(DAT(J),J=1,NV)
0043        IF(K.GT.1)GO TO 10
0044        DO 11 J=1,NV
0045        J2=J
0046        IF(ITYP.EQ.1)J2=J1
0047        RH(J2)=DAT(J)
0048  11    RL(J2)=DAT(J)
0049  10    DO 2 J=1,NV
```

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```
0050          J2=J
0051          IF(ITYP.EQ.1)J2=J1
0052          SUM(J2)=SUM(J2)+DAT(J)
0053          SUM2(J2)=SUM2(J2)+DAT(J)**2
0054          IF(RH(J2).LT.DAT(J))RH(J2)=DAT(J)
0055          IF(RL(J2).GT.DAT(J))RL(J2)=DAT(J)
0056     2    CONTINUE
0057          DO 12 J=1,NV
0058          J2=J
0059          IF(ITYP.EQ.1)J2=J1
0060    12    RH(J2)=RH(J2)-RL(J2)+1
0061          DO 3 J=1,NV
0062          J2=J
0063          IF(ITYP.EQ.1)J2=J1
0064          NS(J2)=NSUB
0065          SMEAN(J2)=SUM(J2)/NS(J2)
0066          AA=NS(J2)
0067     3    SD(J2)=(((AA*SUM2(J2))-(SUM(J2)**2))/(AA*(AA-1.)))**.5
0068          CALL RWNDF(IB)
0069          IF(ITYP.EQ.0)GO TO 21
0070          DO 5 J1=1,K4
0071          NSUB=NS(J1)
0072    21    DO 4 K=1,NSUB
0073          CALL READF(IB,IERR,IBUF)
0074          CALL CODE
0075          READ(IBUF,IFMT)(DAT(J),J=1,NV)
0076          DO 4 J=1,NV
0077          J2=J
0078          IF(ITYP.EQ.1)J2=J1
0079          SUM3(J2)=SUM3(J2)+(DAT(J)-SMEAN(J2))**3
0080          SUM4(J2)=SUM4(J2)+(DAT(J)-SMEAN(J2))**4
0081     4    CONTINUE
0082          DO 5 J=1,NV
0083          J2=J
0084          IF(ITYP.EQ.1)J2=J1
0085          SKEW(J2)=SUM3(J2)/(NS(J2)*(SD(J2)**3))
0086     5    AKURT(J2)=(SUM4(J2)/(NS(J2)*(SD(J2)**4)))-3
0087          IF(ITYP.EQ.1)NV=K4
0088   873    WRITE(1,543)
0089   543    FORMAT(" ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT")
0090          READ(1,*) IUNIY
0091          IF((IUNIY.NE.1).AND.(IUNIY.NE.6)) GO TO 873
0092          WRITE(IUNIY,5431)
0093  5431    FORMAT(" ","VAR#  #SUBJ          MEAN      STD.DEV.",
0094         C"   SKEWNESS    KURTOSIS          RANGE")
0095          WRITE(IUNIY,14)((J,NS(J),SMEAN(J),SD(J),SKEW(J),AKURT(J),
0096         CRH(J)),J=1,NV)
0097    14    FORMAT(" ",I4,2X,I5,2X,F10.3,2X,F10.3,2X,F10.3,2X,F10.3,
0098         C2X,F10.3)
0099          CALL CLOSE (IB)
0100          END
0101          END$
```

B. Analysis of Variance and Covariance

AV10   (CR-k)   (One-way ANOVA)

Purpose:

This program performs a one-way analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ij} = i + B_j + E_{ij}$$

The hypothesis to be tested is:

Ho: $B_j = 0$ for all j

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

Treatment Levels			
b_1	b_2	b_3	b_k

1. There are k levels of treatment B.

2. Subjects are randomly assigned to the treatment levels with each subject designated to receive only one level.

User Considerations and Procedures:

1. A data file must be created with each data point in a sequential file with group one first, then group two, etc. (For example, subject one for treatment b_1 is first record, subject two for treatment b_1 is second record . . ., then subject one for treatment b_2 . . ., subject n for treatment b_j is last record.) A print-out of the raw data file would show only one data point per line.

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2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of subjects (maximum 32767)

   b. number of groups (maximum 100)

   c. number of subjects in each group (maximum 32767)

   d. name of data file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

The F-test is analogous to a t-test for uncorrelated data when the design consists of only two treatment levels. The advantage of this ANOVA design is freedom from the restriction of having an equal number of subjects under each level.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 100-105.

The accuracy of the program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
 RU,AVIØ
AVIØ OR CRK
NOTE:   PROGRAM EXPECTS DATA TO BE IN ONE SEQUENTIAL
           FILE WITH GROUP 1 FIRST THEN GROUP 2, ETC.
NOTE:   MAXIMUM OF 100 GROUPS
ENTER 1 FOR CRT OUTPUT , 6 FOR LPT
6
DO YOU WANT PRINTOUT OF RAW DATA  1 = YES , Ø = NO
1
TOTAL NUMBER OF SUBJECTS?
32
HOW MANY GROUPS?   (maximum 100)
4
ENTER NAME OF INPUT DATA FILE:
#AV2Ø
 ENTER INPUT DATA FORMAT
(4X,F1Ø.4)


ENTER SS/GP BEGINNING WITH GP ONE
   HIT RETURN KEY AFTER EACH ENTRY
8
8
8
8
  AVIØ  :  STOP     ØØØØ
 :
```

```
GROUP      1    RAW DATA
              3.0000
              6.0000
              3.0000
              3.0000
              4.0000
              5.0000
              4.0000
              3.0000
GROUP      2    RAW DATA
              7.0000
              8.0000
              7.0000
              6.0000
              7.0000
              8.0000
              9.0000
              8.0000
GROUP      3    RAW DATA
              1.0000
              2.0000
              2.0000
              2.0000
              2.0000
              3.0000
              4.0000
              3.0000
GROUP      4    RAW DATA
              5.0000
              6.0000
              5.0000
              6.0000
             10.0000
              9.0000
             11.0000
             10.0000
```

GROUP	N	SUMX	SUMX2	MEAN	SD
1	8	31.000	129.000	3.875	1.126
2	8	60.000	456.000	7.500	.926
3	8	19.000	51.000	2.375	.916
4	8	62.000	524.000	7.750	2.493

SOURCE TABLE

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.000			
BETWEEN	171.250	3.000	57.083	24.8768	.00000
WITHIN	64.250	28.000	2.295		

```
0001   FTN4,L
0002          PROGRAM AV10
0003          DOUBLE PRECISION B(80),BSS,XBAR(80),SD(80),DATAX,SX,BS,BB
0004          DOUBLE PRECISION BBS(80),X,BB,SST,SSBG,SSWG,BDF,WDF,TDF,BMS
0005          DOUBLE PRECISION WMS,F,Z,PS
0006          DIMENSION N(80),INFILE(3),IFMT(20)
0007          DIMENSION IB(272),IBUF(256)
0008          SX=0.
0009          BS=0.
0010          BB=0.
0011          WRITE(1,4400)
0012   4400   FORMAT ( "AV10 OR CRK",/,
0013       C "NOTE:  PROGRAM EXPECTS DATA TO BE IN ONE SEQUENTIAL"  ,/,
0014       C "        FILE WITH GROUP 1 FIRST THEN GROUP 2, ETC.",/,
0015       C "NOTE:  MAXIMUM OF 80 GROUPS"  ,/,
0016       C "ENTER 1 FOR CRT OUTPUT , 6 FOR LPT      ")
0017          READ(1,*) IUNIT
0018          WRITE(1,4405)
0019   4405   FORMAT ( "DO YOU WANT PRINTOUT OF RAW DATA  1 = YES , 0 = NO")
0020          READ(1,*)  IPTO
0021          WRITE(1,4406)
0022   4406   FORMAT ( "TOTAL NUMBER OF SUBJECTS?  ")
0023          READ(1,*)  NSUB
0024          WRITE(1,4407)
0025   4407   FORMAT ( "HOW MANY GROUPS? (LIMIT IS 80)   ")
0026          READ(1,*) NGRP
0027          WRITE(1,4408)
0028   4408   FORMAT ( "ENTER NAME OF INPUT DATA FILE:  " )
0029          READ (1,300) INFILE
0030   300    FORMAT (3A2)
0031          WRITE(1,409)
0032   409    FORMAT("ENTER INPUT DATA FORMAT I.E. (F10.4)   ")
0033          READ(1,301) IFMT
0034   301    FORMAT(20A2)
0035          IDCBB=256
0036          CALL OPEN (IB,IER,INFILE,3,0,-2,IDCBS)
0037          IF(IER.GE.0) GO TO 870
0038          WRITE(1,655) INFILE,IER
0039   655    FORMAT(5X,3A2," FAILED TO OPEN , IER = &&&",I5)
0040          STOP 655
0041   870    WRITE(1,4410)
0042   4410   FORMAT ( "ENTER SUBJECTS/GROUP BEGINNING WITH GROUP ONE"  ,/,
0043       C   "HIT RETURN KEY AFTER EACH ENTRY" )
0044          DO 3 J=1,NGRP
0045   3      READ(1,*) N(J)
0046   90     FORMAT(/," GROUP",3X,"N ",7X,"SUMX",8X,"SUMX2",9X,"MEAN",
0047       $11X,"SD")
0048          DO 5 J=1,NGRP
0049          LL=N(J)
0050          IF(IPTO.EQ.1)WRITE(IUNIT,2)J
0051   2      FORMAT(" GROUP   ",I2,"   RAW DATA")
0052          DO 4 K=1,LL
0053          CALL READF(IB,IER,IBUF)
0054          CALL CODE
```

```
0055          READ (IBUF,IFMT) DATAX
0056          IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)DATAX
0057          SX=SX+DATAX
0058          BS=BS+DATAX**2
0059          BBS(J)=BBS(J)+DATAX**2
0060    4     B(J)=B(J)+DATAX
0061          XBAR(J)=B(J)/N(J)
0062          SD(J)=DSQRT((BBS(J)-(B(J)**2)/N(J))/(N(J)-1))
0063    5     CONTINUE
0064          WRITE(IUNIT,90)
0065          DO 50 J=1,NGRP
0066   50     WRITE (IUNIT,100)J,N(J),B(J),BBS(J),XBAR(J),SD(J)
0067  100     FORMAT(1X,I3,3X,I3,4(3X,F10.3))
0068          X=(SX**2)/NSUB
0069          DO 6 L=1,NGRP
0070    6     BB=BB+((B(L)**2)/N(L))
0071          SST=BS-X
0072          SSBG=BB-X
0073          SSWG=BS-BB
0074          BDF=NGRP-1
0075          WDF=NSUB-NGRP
0076          TDF=NSUB-1
0077          BMS=SSBG/BDF
0078          WMS=SSWG/WDF
0079          F=BMS/WMS
0080          CALL FPROB (F,BDF,WDF,Z,PS)
0081          WRITE(IUNIT,875)
0082  875     FORMAT(//,15X,"SOURCE TABLE ",/)
0083          WRITE (IUNIT,200) SST,TDF,SSBG,BDF,BMS,F,PS,SSWG,WDF,WMS
0084  200     FORMAT (/," SOURCE            SS            DF",10X,
0085        $"MS              F              P"
0086        $//," TOTAL      ",2F13.3,
0087        $/," BETWEEN   ",3F13.3,2X,F11.4,2X,F9.5,/,
0088        $" WITHIN    ",3F13.3)
0089          CALL CLOSE (IB,IER)
0090          STOP
0091          END
0092          END$
```

AV11   (RB-k)   (One-way ANOVA, Repeated Measures)

Purpose:

 This program performs a one-way analysis of variance with repli-
 cation either by using matched subjects or repeated measures.

Mathematical Model:

 The model for this design is:

 $$X_{ij} = u + B_j + \pi_i + E_{ij}$$

 The hypothesis to be tested is:

 Ho: $B_j = 0$ for all j

 The fixed effect model (Model I) was assumed in the deviation of
 the expected values of the mean squares.

Layout of Design:

Treatment Levels			
b_1	b_2	b_3	b_k

1. There are k levels of treatment B.

2. Subjects are assigned to a treatment so that variability within
    a treatment is less than the variability among treatments.
    Homogeneity within treatments may be achieved by using a sub-
    ject as his own control or by using subjects matched on the
    basis of a variable that correlates with the dependent variable.

User Considerations and Procedures:

1. A data file must be created with each data point in a matrix
    file. On input, index for within factor varies most rapidly.
    (For example, first record is subject one, treatment b_1, subject
    one, treatment b_2 . . . ., subject one, treatment b_k; second record
    subject two, treatment b_1, subject two, treatment b_2 . . . ., subject
    two, treatment b_k . . .; the last record is subject n, treatment
    b_1, subject n, treatment b_2 . . . ., subject n, treatment b_k.) A
    printout of the raw data file would show k data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of subjects (maximum 32767)

   b. number of groups (maximum 100)

   c. number of subjects in each group (maximum 32767)

   d. name of file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

The F-test is analogous to a t-test for correlated data when the design consists of only two treatment levels. This ANOVA design permits an experimenter to minimize the effects of individual differences. However, the design requires that the population covariances for all pairs of treatment levels be homogeneous.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 132-134.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for the Social Sciences.

```
    RU,AV11
AV11 OR RBK
  *** ONE WAY ANOVA FOR REPEATED MEASURES ***
     NOTE:   DATA .NPUT READ SEQUENCE, INDEX FOR WITHIN
             FACTOR VARIES MOST RAPIDLY.  PROGRAM EXPECTS ALL
             DATA TO BE IN ONE MATRIX FILE.
     NOTE:   MAXIMUM OF 100 TREATMENTS (WITHIN FACTOR)
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER # SS/GP
8
ENTER # LEVELS FOR TREATMENTS:
4
ENTER NAME OF DATA FILE:
#AV11


ENTER FORMAT OF DATA:
(4(4X,F1Ø.4))
:
```

RAW DATA

3.0000	7.0000	4.0000	7.0000
6.0000	8.0000	5.0000	8.0000
3.0000	7.0000	4.0000	9.0000
3.0000	6.0000	3.0000	8.0000
1.0000	5.0000	2.0000	10.0000
2.0000	6.0000	3.0000	10.0000
2.0000	5.0000	4.0000	9.0000
2.0000	6.0000	3.0000	11.0000

TREATMENT	N	SUMX	SUMX2	MEAN	SD
1	8	22.000	76.000	2.750	1.488
2	8	50.000	320.000	6.250	1.035
3	8	28.000	104.000	3.500	.926
4	8	72.000	660.000	9.000	1.309

SOURCE TABLE

SOURCE	SS	DF	MS	F	P
TOTAL	235.50000	31.			
TREATMENT	194.5000	3.	64.8333	47.7719	.00000
SUBJECTS	12.5000	7.	1.7857	1.3158	.29097
RESIDUAL	28.5000	21.	1.3571		

```
0001   FTN4,L
0002        PROGRAM AV11
0003        DIMENSION IFMT(20),INFILE(3)
0004        DOUBLE PRECISION S2(80),DMTX(80),XS2(80),S3,S4,SS,CT,SST
0005        DOUBLE PRECISION SSS,S11,S3TR,SSER,XBAR(80),SD(80)
0006        DOUBLE PRECISION RMSS,RMSTR,RMSER,FS,FTR,TEMP
0007        DOUBLE PRECISION DFT,DFS,DFTR,DFER,DF1,DF2,F,Z,PS
0008        DIMENSION IB(272),IBUF(256)
0009        WRITE(1,4400)
0010   4400 FORMAT ( "$AV11 OR RBK" ,/,
0011      C" *** ONE WAY ANOVA FOR REPEATED MEASURES ***"  ,//,
0012      C"  NOTE:  DATA INPUT READ SEQUENCE, INDEX FOR WITHIN",/,
0013      C"           FACTOR VARIES MOST RAPIDLY.  PROGRAM EXPECTS ALL",/,
0014      C"           DATA TO BE IN ONE MATRIX FILE." ,/,
0015      C"  NOTE:  MAXIMUM OF 80 TREATMENTS WITHIN FACTOR   " ,//,
0016      C"ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: ")
0017        READ(1,*)  IUNIT
0018        WRITE(1,4409)
0019   4409 FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO    ")
0020        READ(1,*)  IPTO
0021        WRITE(1,4410)
0022   4410 FORMAT ( "ENTER # SUBJECTS/GROUP  ")
0023        READ(1,*) NS
0024        WRITE(1,4411)
0025   4411 FORMAT ( "ENTER # LEVELS FOR TREATMENTS: ")
0026        READ(1,*)  NLU
0027        WRITE(1,4412)
0028   4412 FORMAT ( "ENTER NAME OF DATA FILE:" )
0029        READ(1,106)INFILE
0030   106  FORMAT(3A2)
0031        IDCBS=256
0032        CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0033        IF(IER.GE.0)GO TO 101
0034        WRITE(1,4413) INFILE,IER
0035   4413 FORMAT(5X,3A2,5X,"DATA FILE FAILED TO OPEN, IER = ",I5 )
0036        STOP 4413
0037   101  WRITE(1,4414)
0038   4414 FORMAT ( "ENTER FORMAT OF DATA: I.E. (4F10.4) ")
0039        READ(1,102)IFMT
0040   102  FORMAT(20A2)
0041        IF(IPTO.EQ.1)WRITE(IUNIT,1)
0042   1    FORMAT(" RAW DATA")
0043        DO 20 K=1,NS
0044        CALL READF(IB,IER,IBUF,IDCBS)
0045        CALL CODE
```

```
0046        READ(IBUF,IFMT)(DMTX(J),J=1,NLU)
0047        IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)(DMTX(J),J=1,NLU)
0048        TEMP=0
0049        DO 10 I=1,NLU
0050        NM=NM+1
0051        S2(I)=S2(I)+DMTX(I)
0052        XS2(I)=XS2(I)+DMTX(I)**2
0053        S3=S3+DMTX(I)**2
0054        S4=S4+DMTX(I)
0055        TEMP=TEMP+DMTX(I)
0056   10   CONTINUE
0057        S8=S8+TEMP**2
0058   20   CONTINUE
0059        CT=S4**2/NM
0060        SST=S3-CT
0061        SSS=(S8/NLU)-CT
0062        DO 30 I=1,NLU
0063        XBAR(I)=S2(I)/NS
0064   30   S11=S11+S2(I)**2
0065        S11=S11/NS
0066        SSTR=S11-CT
0067        SSER=SST-SSS-SSTR
0068        DFT=NM-1
0069        DFS=NS-1
0070        DFTR=NLU-1
0071        DFER=DFT-DFS-DFTR
0072        RMSS=SSS/DFS
0073        RMSTR=SSTR/DFTR
0074        RMSER=SSER/DFER
0075        FS=RMSS/RMSER
0076        FTR=RMSTR/RMSER
0077        DF1=DFS
0078        DF2=DFER
0079        F=FS
0080        CALL FPROB(F,DF1,DF2,Z,PS)
0081        DF1=DFTR
0082        DF2=DFER
0083        F=FTR
0084        CALL FPROB(F,DF1,DF2,Z,PTR)
0085        DO 50 I=1,NLU
0086        ANS=NS
0087   50   SD(I)=DSQRT((ANS*XS2(I)-(S2(I)**2))/(ANS*(ANS-1.)))
0088        WRITE(IUNIT,51)(I,NS,S2(I),XS2(I),XBAR(I),SD(I),I=1,NLU)
0089   51   FORMAT(//," TREATMENT        N         SUMX         SUMX2
0090       $  MEAN          SD",//,
0091       $(I7,8X,I3,4X,F10.3,2X,F10.3,2X,F10.3,2X,F10.3))
0092        WRITE(IUNIT,105)SST,DFT,SSTR,DFTR,RMSTR,FTR,PTR,SSS,DFS,RMSS,
0093       $FS,PS,SSER,DFER,RMSER
0094  105   FORMAT(///,15X,"SOURCE TABLE ",///,X,"SOURCE ",12X,"SS",9X,
0095       $"DF",11X,"MS",11X,"F",10X,"P",//," TOTAL",9X,F12.4,1X,F6.0,
0096       $/," TREATMENT   ",2X,F12.4,1X,F6.0,3X,F12.4,3X,F10.4,3X,
0097       %F6.5,/," SUBJECTS   ",4X,F12.4,1X,F6.0,3X,F12.4,3X,F10.4,3X,
0098       &F6.5,/," RESIDUAL   ",X,F12.4,1X,F6.0,3X,F12.4)
0099        CALL CLOSE(IB)
0100        END
0101        END$
```

AV20   (CRF-P,Q)   (Two-way ANOVA)

Purpose:

This program performs a two-way completely randomized facotrial analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + AB_{ij} + E_{m(ij)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A_1		A_2		A_3	
B_1	B_2	B_1	B_2	B_1	B_2
S_1	S_2	S_3	S_4	S_5	S_6

S represents a set of subjects

1. There are two factors (A,B) with p and q levels of treatments respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.

2. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination.

3. There should be more than one subject per pq treatment combinations.

User Considerations and Procedures:

1. A data file must be created with each data point in a sequential file. On input, Factor B varies most rapidly, then Factor A. (For example, first record is subject one for treatment ab_{11}, second record subject two, treatment ab_{11} . . ., then subject one treatment ab_{12}, next is subject two, ab_{12} . . ., then subject one treatment ab_{21} . . ., final record would be subject n for treatment ab_{pq}.) A printout of the raw data file would show one data point per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if a raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

    a. number of levels of Factor A (maximum 30)

    b. number of levels of Factor B (maximum 30)

    c. number of subjects per AB cell (maximum 32767)

    d. name of data file

    e. format of data file

5. Printout gives:

    a. raw data (option)

    b. for each cell: Σ, Σx^2, $\overline{X}$, SD (unbiased estimate)

    c. ANOVA source table

Comments:

Program uses least square analysis for unequal cell sample sizes. This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, <u>Experimental</u> <u>Design Procedures for the Behavioral Sciences</u>, Wadsworth Publishing Company, 1968, Pp. 175-176.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
  RU,AV2Ø
AV2Ø OR CRFPQ
REF: BRUNING & KINTZ, 1968
SECTION 2.2
FACTORIAL DESIGN:   TWO FACTORS
     NOTE:   PROGRAM CALCULATES LEAST SQUARES
             SOLUTION IF UNEQUAL CELL N'S
     NOTE:   ON INPUT DATA READ SEQUENCE, INDEX
             FOR FACTOR B VARIES MOST
             RAPIDLY.   PROGRAM EXPECTS DATA TO BE IN
             ONE SEQUENTIAL FILE.
     NOTE:   MAX 30 * 30  DESIGN
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
DO YOU WANT TO PRINT OUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER INPUT DATA FILE NAME:
#AV2Ø


ENTER INPUT DATA FORMAT:
(4X,F1Ø.4)
ENTER # LEVELS ON FACTOR A & B:
2,4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          3
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          4
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          3
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          4
ENTER # SS THIS CELL:
4
:
```

```
GROUP      1  1    RAW DATA
           3.0000
           6.0000
           3.0000
           3.0000
GROUP      1  2    RAW DATA
           4.0000
           5.0000
           4.0000
           3.0000
GROUP      1  3    RAW DATA
           7.0000
           8.0000
           7.0000
           6.0000
GROUP      1  4    RAW DATA
           7.0000
           8.0000
           9.0000
           8.0000
GROUP      2  1    RAW DATA
           1.0000
           2.0000
           2.0000
           2.0000
GROUP      2  2    RAW DATA
           2.0000
           3.0000
           4.0000
           3.0000
GROUP      2  3    RAW DATA
           5.0000
           6.0000
           5.0000
           6.0000
GROUP      2  4    RAW DATA
          10.0000
           9.0000
          11.0000
          10.0000
```

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	4	15.000	63.000	3.750	1.500
1 2	4	16.000	66.000	4.000	.816
1 3	4	28.000	198.000	7.000	.816
1 4	4	32.000	258.000	8.000	.816
2 1	4	7.000	13.000	1.750	.500
2 2	4	12.000	38.000	3.000	.816
2 3	4	22.000	122.000	5.500	.577
2 4	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
FACTOR A	3.125	1.	3.125	4.054	.052693
FACTOR B	194.500	3.	64.833	84.108	.000000
A * B	19.375	3.	6.458	8.378	.000788
ERROR	18.500	24.	.771		

```
0001   FTN4,L
0002         PROGRAM AV20
0003         DOUBLE PRECISION SX2(20,20),S2(20,20),S6(20),S7(20),RDATA
0004         DOUBLE PRECISION S3,S4,CT,SST,SSA,SSB,PAB,PB
0005         DOUBLE PRECISION SSAB,SSER,MSB,MSA,MSAB,MSER,FA,FB,FAB
0006         DOUBLE PRECISION TSS,XBAR,DFT,DFA,DFB,DFAB,DFER,F,DF1,DF2,Z,PA
0007         DIMENSION IB(272),IBUF(256)
0008         DIMENSION NS(20,20),IFMT(20),NS6(20),NS7(20)
0009         DIMENSION INFILE(3)
0010         WRITE(1,4400)
0011   4400  FORMAT ( "AV20 OR CRFPQ&" ,/,
0012       C "REF: BRUNING & KINTZ, 1968" ,/,
0013       C "SECTION 2.2"  ,/,
0014       C "FACTORIAL DESIGN:  TWO FACTORS" ,/,
0015       C "     NOTE:  PROGRAM CALCULATES LEAST SQUARES" ,/,
0016       C "     SOLUTION IF UNEQUAL CELL N'S" ,)
0017         WRITE(1,4401)
0018   4401  FORMAT("     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX" ,/,
0019       C "     FOR FACTOR B VARIES MOST" ,/,
0020       C "     RAPIDLY.  PROGRAM EXPECTS DATA TO BE IN"  ,/,
0021       C "     ONE SEQUENTIAL FILE." ,/,
0022       C "     NOTE:  MAX 20 * 20 DESIGN" ,//)
0023   290   WRITE(1,4411)
0024   4411  FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT: ")
0025         READ(1,*)  IUNIT
0026         IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 290
0027         WRITE(1,4412)
0028   4412  FORMAT("DO YOU WANT TO PRINT OUT OF RAW DATA 1= YES , 0= NO")
0029         READ(1,*) IPTO
0030         WRITE(1,4413)
0031   4413  FORMAT ( "ENTER INPUT DATA FILE NAME:"  )
0032         READ(1,194)INFILE
0033   194   FORMAT(3A2)
0034   191   FORMAT(20A2)
0035         IDCBS=256
0036         IF(LENGTH.LT.144) IDCBS=144
0037         CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0038         IF(IER.GE.0)GO TO 19155
0039         WRITE(1,4414) IER
0040   4414  FORMAT ( "NO OPEN INPUT DATA FILE, IER = "I5  )
0041         STOP
0042   19155 WRITE(1,4415)
0043   4415  FORMAT ( "ENTER INPUT DATA FORMAT: I.E. (F10.4)"  )
0044         READ(1,191)IFMT
0045         WRITE(1,4416)
0046   4416  FORMAT ( "ENTER # LEVELS ON FACTOR A & B:  ")
0047         READ(1,*) NLA,NLB
0048         NGPS=NLA*NLB
0049         DO 1915 LA=1,NLA
0050         DO 1915 LB=1,NLB
0051         WRITE(1,4417) LA
```

```
0052   4417    FORMAT ( "FACTOR A, LEVEL: ",I5 )
0053           WRITE(1,4418) LB
0054   4418    FORMAT ( "FACTOR B, LEVEL: ",I5 )
0055           WRITE(1,4419)
0056   4419    FORMAT ( "ENTER # SUBJECTS THIS CELL:  ")
0057           READ(1,*) NS(LA,LB)
0058           K=NS(LA,LB)
0059           TSS=TSS+K
0060           IF(IPTO.EQ.1)WRITE(IUNIT,2)LA,LB
0061   2       FORMAT(" GROUP   ",2I3,"   RAW DATA")
0062           DO 1914 N=1,K
0063           CALL READF(IB,IER,IBUF)
0064           CALL CODE
0065           READ(IBUF,IFMT)RDATA
0066           IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)RDATA
0067           S2(LA,LB)=S2(LA,LB)+RDATA
0068           S3=S3+RDATA**2
0069           S4=S4+RDATA
0070           S6(LA)=S6(LA)+RDATA
0071           S7(LB)=S7(LB)+RDATA
0072           NS6(LA)=NS6(LA)+1
0073           NS7(LB)=NS7(LB)+1
0074           SX2(LA,LB)=SX2(LA,LB)+RDATA**2
0075   1914    CONTINUE
0076   1915    CONTINUE
0077           WRITE(IUNIT,3004)
0078           DO 3005 I1=1,NLA
0079           DO 3005 I2=1,NLB
0080           XBAR=S2(I1,I2)/NS(I1,I2)
0081           ANS=NS(I1,I2)
0082           SD=DSQRT((ANS*SX2(I1,I2)-S2(I1,I2)**2)/
0083          $(ANS*(ANS-1.)))
0084   3005    WRITE(IUNIT,301)I1,I2,NS(I1,I2),S2(I1,I2),SX2(I1,I2),XBAR,SD
0085   3004    FORMAT("0   CELL        N        SUMX       SUMX2      MEAN"
0086          $,"            SD")
0087   301     FORMAT(2X,2I3,3X,I4,3X,4(1X,F10.3))
0088           CT=S4**2/TSS
0089           SST=S3-CT
0090           DO 699 LA=1,NLA
0091   699     SSA=SSA+S6(LA)**2/NS6(LA)
0092           SSA=SSA-CT
0093           DO 799 LB=1,NLB
0094   799     SSB=SSB+S7(LB)**2/NS7(LB)
0095           SSB=SSB-CT
0096           DO 899 LA=1,NLA
0097           DO 899 LB=1,NLB
0098   899     SSAB=SSAB+S2(LA,LB)**2/NS(LA,LB)
0099           SSAB=SSAB-SSA-SSB-CT
0100           SSER=SST-SSA-SSB-SSAB
0101           DFT=TSS-1
0102           DFA=NLA-1
0103           DFB=NLB-1
0104           DFAB=DFA*DFB
0105           DFER=DFT-DFA-DFB-DFAB
0106           MSA=SSA/DFA
0107           MSB=SSB/DFB
0108           MSAB=SSAB/DFAB
0109           MSER=SSER/DFER
```

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```
0110        FA=MSA/MSER
0111        FB=MSB/MSER
0112        FAB=MSAB/MSER
0113        F=FA
0114        DF1=DFA
0115        DF2=DFER
0116        CALL FPROB(F,DF1,DF2,Z,PA)
0117        F=FB
0118        DF1=DFB
0119        DF2=DFER
0120        CALL FPROB(F,DF1,DF2,Z,PB)
0121        F=FAB
0122        DF1=DFAB
0123        DF2=DFER
0124        CALL FPROB(F,DF1,DF2,Z,PAB)
0125        WRITE(IUNIT,1299)SST,DFT,SSA,DFA,MSA,FA,PA,SSB,DFB,MSB,FB,PB,
0126       $SSAB,DFAB,MSAB,FAB,PAB,SSER,DFER,MSER
0127   1299 FORMAT("0  SOURCE",8X,"SS",5X,"DF",6X,"MS",9X,"F",11X,"P"//
0128       $" TOTAL",6X,F10.3,F5.0/3X,"FACTOR A ",F10.3,F5.0,2F10.3,F10.6/
0129       $3X,"FACTOR B ",F10.3,F5.0,2F10.3,F10.6/3X,"A * B",4X,F10.3,
0130       $F5.0,2F10.3,F10.6,/5X,"ERROR  ",F10.3,F5.0,F10.3)
0131        CALL CLOSE(IB,IER)
0132          END
0133          END$
```

AV21B   (SPF-P.Q)   (Two-way Split Plot ANOVA, Repeated Measures)

Purpose:

This program performs a two-way split-plot or mixed analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + AB_{ij} + \pi_{m(i)} + B\pi_{jm(i)} + E_{o(ijm)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The mixed effect model (Model III) was used in the derivation of the expected values of the mean squares.

Layout of Design:

	B_1	B_2	B_3
A_1	S_1	S_1	S_1
A_2	S_2	S_2	S_2

S represents a set of subjects

1. There are two Factors (A and B) with p, q levels of treatments respectively. Factor A is designated as the between block or nonrepeated measure. Factor B is the within block repeated measure. The above example includes two levels of Factor A, three levels of Factor B.

2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatment B are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

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User Considerations and Procedures:

1. A matrix data file must be created with all data points for each subject in one record. On read input, the within Factor B varies fastest, then Factor A. (For example, record one contains subject 1, cell ab_{11}, ab_{12} . . . ., ab_{1q}; second record is subject 2, ab_{11}, ab_{12} . . . ., ab_{1q}; etc. Repeat the same procedure for subjects in Factor A_p.) A printout of the raw data would show q data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of between Factor A (maximum 25)

   b. number of levels of within Factor B (maximum 25)

   c. number of subjects per AB cell (maximum 32767)

   d. name of data file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

Program uses least squares analysis for unequal cell sizes on Factor A. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within block (Factor B and inter-action AB) effects are more accurate than estimates of between block (Factor A) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV22). However, if equal precision for all treatment effects is desired, the average power of a random-ized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

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Test Data:

This program was tested using data from Roger E. Kirk, <u>Experimental Design Procedures for the Behavioral Sciences</u>, Wadsworth Publishing Company, 1968, Pp. 249-251.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
  RU,AV21B
AV21B OR SPFPQ
REF: BRUNING & KINTZ, 1968
SECTION 2.7
TWO FACTOR MIXED DESIGN:  REPEATED MEASURES ON ONE FACTOR
     NOTE:   PROGRAM CALCULATES LEAST SQUARES SOLUTION
             IF UNEQUAL CELL N'S
     NOTE:   ON INPUT DATA READ SEQUENCE, INDEX FOR
             WITHIN FACTOR (B) VARIES MOST RAPIDLY.
             PROGRAM EXPECTS ALL DATA TO BE IN
             ONE MATRIX FILE.
     NOTE:   MAX 25B * 25W DESIGN
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:
6
DO YOU WANT TO PRINT OUT DATA 1 = YES , Ø = NO
1
ENTER INPUT DATA FILE NAME:
#AV11


ENTER INPUT DATA FORMAT:
(4(4X,F1Ø.4))
ENTER # LEVELS FOR BETWEEN FACTOR (MAX 25):
2
ENTER # LEVELS FOR WITHIN FACTOR (MAX 25):
4
GROUP NUMBER.      1
ENTER NUMBER OF SUBJECTS IN THIS GROUP:
4
GROUP NUMBER:      2
ENTER NUMBER OF SUBJECTS IN THIS GROUP:
4
:
```

```
GROUP:      1   RAW DATA
    3.000      7.000      4.000      7.000
    6.000      8.000      5.000      8.000
    3.000      7.000      4.000      9.000
    3.000      6.000      3.000      8.000
GROUP:      2   RAW DATA
    1.000      5.000      2.000     10.000
    2.000      6.000      3.000     10.000
    2.000      5.000      4.000      9.000
    2.000      6.000      3.000     11.000
```

CELL		N	SUMX	SUMX2	MEAN	STD DEV
1	1	4	15.000	63.000	3.750	1.500
1	2	4	28.000	198.000	7.000	.816
1	3	4	16.000	66.000	4.000	.816
1	4	4	32.000	258.000	8.000	.816
2	1	4	7.000	13.000	1.750	.500
2	2	4	22.000	122.000	5.500	.577
2	3	4	12.000	38.000	3.000	.816
2	4	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN	12.500	7.			
FACTOR A	3.125	1.	3.125	2.000	.205762
ERROR BTW	9.375	6.	1.562		
WITHIN	223.000	24.			
FACTOR B	194.500	3.	64.833	127.890	.000000
A * B	19.375	3.	6.458	12.740	.000228
ERROR W/IN	9.125	18.	.507		

```
0001   FTN4,L
0002          PROGRAM AV21B
0003          DOUBLE PRECISION DVECTR(20),SASX(20),SASX2(20),SS(20)
0004          DOUBLE PRECISION MSC,MSERRB,MSTR,MSTRXC,FC,FTR,Z,PC,PTR,PTRXC
0005          DOUBLE PRECISION DSX(20,20),DSX2(20,20),GSX2(20),GSX(20)
0006          DOUBLE PRECISION TEMP,TSX2,CT,SST,SSC,SSB,SSW,FTRXC,F,DF1,DF2
0007          DOUBLE PRECISION MSERRW,GT,SSTRXC,SSTR,DFTRXC,DFSERW
0008          DOUBLE PRECISION SIG(20,20),SAXS2(20),XBAR(20,20),TNS,SSERRB
0009          DOUBLE PRECISION SSERRW,DFSB,DFST,DFSC,DFSERB,DFSW,DFSTR
0010          DIMENSION IB(272),IBUF(256),IFILE(3),NSS(20),IFMT(20)
0011          WRITE(1,4400)
0012   4400   FORMAT ( "AV21B OR SPFPQ" ,/,
0013        C "REF: BRUNING & KINTZ, 1968" ,/,
0014        C "SECTION 2.7"  ,/,
0015        C"TWO FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR",/,
0016        C"     NOTE:  PROGRAM CALCULATES LEAST SQUARES SOLUTION",/,
0017        C "              IF UNEQUAL CELL N'S"  )
0018          WRITE(1,4406)
0019   4406   FORMAT ( "     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR",/,
0020        C "              WITHIN FACTOR (B) VARIES MOST RAPIDLY." ,/,
0021        C "              PROGRAM EXPECTS ALL DATA TO BE IN"  ,/,
0022        C "              ONE MATRIX FILE." ,/,
0023        C "     NOTE:  MAX 20B * 20W DESIGN" )
0024   1      WRITE(1,4411)
0025   4411   FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:  ")
0026          READ(1,*) IUNIT
0027          IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 97
0028          WRITE(1,4412)
0029   4412   FORMAT ( "DO YOU WANT TO PRINT OUT DATA 1 = YES , 0 = NO    ")
0030          READ(1,*)  IPTO
0031          WRITE(1,4413)
0032   4413   FORMAT ( "ENTER INPUT DATA FILE NAME:"  )
0033          READ(1,85)IFILE
0034   85     FORMAT(3A2)
0035          IDCBS=256
0036          CALL OPEN(IB,IER,IFILE,3,0,-2,IDCBS)
0037          IF(IER.LT.0)GO TO 98
0038          WRITE(1,4414)
0039   4414   FORMAT ( "ENTER INPUT DATA FORMAT I.E. (4F10.4)" )
0040          READ(1,80)IFMT
0041   80     FORMAT(20A2)
0042          WRITE(1,4415)
0043   4415   FORMAT ( "&ENTER # LEVELS FOR BETWEEN FACTOR (MAX 20):   ")
0044          READ(1,*) NGPS
0045          WRITE(1,4416)
0046   4416   FORMAT ( "&ENTER # LEVELS FOR WITHIN FACTOR (MAX 20):   ")
0047          READ(1,*) NLW
0048          DO 19 NG=1,NGPS
0049          WRITE(1,4417) NG
0050   4417   FORMAT ( "GROUP NUMBER: ",I5  )
0051          WRITE(1,4418)
0052   4418   FORMAT ( "ENTER NUMBER OF SUBJECTS IN THIS GROUP:  ")
0053          READ(1,*) ISS
```

```
0054          TNS=TNS+ISS
0055          NSS(NG)=ISS
0056          IF(IPTO.EQ.1)WRITE(IUNIT,2)NG
0057     2    FORMAT(" GROUP:    ",I3,"    RAW DATA")
0058          DO 10 J2=1,ISS
0059          CALL READF(IB,IER,IBUF)
0060          CALL CODE
0061          READ(IBUF,IFMT)(DVECTR(J1),J1=1,NLW)
0062          TEMP=0.
0063          IF(IPTO.EQ.1)WRITE(IUNIT,9)(DVECTR(J3),J3=1,NLW)
0064     9    FORMAT(10F9.3)
0065          DO 7 J1=1,NLW
0066          TEMP=TEMP+DVECTR(J1)
0067          SASX(NG)=SASX(NG)+DVECTR (J1)
0068          SASX2(NG)=SASX2(NG)+DVECTR(J1)**2
0069          DSX(NG,J1)=DSX(NG,J1)+DVECTR(J1)
0070          DSX2(NG,J1)=DSX2(NG,J1)+DVECTR(J1)**2
0071     7    CONTINUE
0072          SAXS2(NG)=SAXS2(NG)+TEMP**2
0073     10   CONTINUE
0074          SS(NG)=NSS(NG)
0075          DO 11 J1=1,NLW
0076          XBAR(NG,J1)=DSX(NG,J1)/SS(NG)
0077          SIG(NG,J1)=DSQRT((SS(NG)*DSX2(NG,J1)-DSX(NG,J1)**2)/
0078         $(SS(NG)*(SS(NG)-1)))
0079          GSX(NG)=GSX(NG)+DSX(NG,J1)
0080          GSX2(NG)=GSX2(NG)+DSX2(NG,J1)
0081     11   CONTINUE
0082     19   CONTINUE
0083          WRITE (IUNIT,1904)
0084     1904 FORMAT(/" CELL        H      SUMX       SUMX2      MEAN       ",
0085         C"STD DEV")
0086          DO 191 J1=1,NGPS
0087     1905 FORMAT(2I3,I6,4F10.3)
0088          WRITE(IUNIT,1905)(J1,J5,NSS(J1),DSX(J1,J3),DSX2(J1,J5),
0089         $XBAR(J1,J5),SIG(J1,J5),J5=1,NLW)
0090     191  CONTINUE
0091          DO 1915 J1=1,NGPS
0092          TSX2=TSX2+GSX2(J1)
0093     1915 GT=GT+GSX(J1)
0094          CT=GT**2/(TNS*NLW)
0095          SST=TSX2-CT
0096          DO 1916 J1=1,NGPS
0097          SSC=SSC+GSX(J1)**2/(SS(J1)*NLW)
0098     1916 SSB=SSB+SAXS2(J1)
0099          SSB=SSB/NLW-CT
0100          SSC=SSC-CT
0101          SSERRB=SSB-SSC
0102          SSW=SST-SSB
0103          TEMP=0
0104          DO 1976 J1=1,NLW
0105          DO 1975 K1=1,NGPS
0106          SSTRXC=SSTRXC+DSX(K1,J1)**2/SS(K1)
0107     1975 TEMP=TEMP+DSX(K1,J1)
0108          TEMP=TEMP**2/TNS
0109          SSTR=SSTR+TEMP
0110     1976 TEMP=0.
```

```
0111          SSTR=SSTR-CT
0112          SSTRXC=SSTRXC-SSC-SSTR-CT
0113          SSERRW=SSW-SSTR-SSTRXC
0114          DO 199 J1=1,NGPS
0115          DFSB=DFSB+SS(J1)
0116    199   DFST=DFST+SS(J1)
0117          DFST=DFST*NLW-1
0118          DFSB=DFSB-1
0119          DFSC=NGPS-1
0120          DFSERB=DFSB-DFSC
0121          DFSW=DFST-DFSB
0122          DFSTR=NLW-1
0123          DFTRXC=DFSTR*DFSC
0124          DSFERW=DFSW-DFSTR-DFTRXC
0125          MSC=SSC/DFSC
0126          MSERRB=SSERRB/DFSERB
0127          MSTR=SSTR/DFSTR
0128          MSTRXC=SSTRXC/DFTRXC
0129          MSERRW=SSERRW/DSFERW
0130          FC=MSC/MSERRB
0131          FTR=MSTR/MSERRW
0132          FTRXC=MSTRXC/MSERRW
0133          F=FC
0134          DF1=DFSC
0135          DF2=DFSERB
0136          CALL FPROB(F,DF1,DF2,Z,PC)
0137          F=FTR
0138          DF1=DFSTR
0139          DF2=DSFERW
0140          CALL FPROB(F,DF1,DF2,Z,PTR)
0141          F=FTRXC
0142          DF1=DFTRXC
0143          DF2=DSFERW
0144          CALL FPROB(F,DF1,DF2,Z,PTRXC)
0145    20    FORMAT("0    SOURCE          SS       DF        MS        F       ",
0146          C"      P",//" TOTAL",
0147          $9X,F10.3,F5.0/"    BETWEEN       ",F10.3,F5.0/"      FACTOR A  "
0148          $,F10.3,F5.0,2F10.3,F10.6/"      ERROR BTW ",F10.3,F5.0,F10.3//
0149          $"    WITHIN",6X,F10.3,F5.0/5X,"FACTOR B  ",F10.3,F5.0,2F10.3,
0150          $F10.6,/,5X,"A * B",5X,F10.3,F5.0,2F10.3,F10.6/5X,"ERROR W/IN",
0151          $F10.3,F5.0,F10.3)
0152          WRITE(IUNIT,20)SST,DFST,SSB,DFSB,SSC,DFSC,MSC,FC,PC,SSERRB,
0153          $DFSERB,
0154          $MSERRB,SSW,DFSW,SSTR,DFSTR,MSTR,FTR,PTR,SSTRXC,DFTRXC,MSTRXC,
0155          $FTRXC,PTRXC,SSERRW,DSFERW,MSERRW
0156          CALL CLOSE(IB,IER)
0157          GO TO 834
0158    98    WRITE(1,4420) IER
0159    4420  FORMAT ( "INPUT DATA FILE FAILED TO OPEN, ERROR CODE: ",I5 )
0160          STOP
0161    97    WRITE(1,4421)
0162    4421  FORMAT ( "INVALID OUTPUT UNIT #"  )
0163          GO TO 1
0164    834   END
0165          END$
```

AV22   (RBF-P,Q) (Two-way ANOVA, Repeated Measures)

Purpose:

This program performs a two-way randomized block factorial analysis of variance with replication either by using matched subjects or repeated measures with one subject.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + AB_{ij} + \pi_m + E_{ijm}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $AB_{ij} = 0$ for all ij

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A_1		A_2		A_3	
B_1	B_2	B_1	B_2	B_1	B_2
S_1	S_1	S_1	S_1	S_1	S_1

S represents a set of subjects

1. There are two Factors (A,B) with p and q levels of treatments respectively. The experiment consists of pq treatment combinations. The above example includes three levels of Factor A, two levels of Factor B.

2. Subjects are randomly assigned to the pq treatment combinations with each subject or a set of matched subjects receiving all combinations. The order of administration of the pq combinations is randomized independently for each subject. If sets of matched subjects are used, one subject from each set is randomly assigned to each treatment combination.

3. There should be more than one subject per pq treatment combinations.

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User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor B varies most rapidly; then Factor A, then subjects. (For example, record one contains subject one, treatments ab_{11}, ab_{12} . . ., ab_{1q}; record two, subject one, treatment ab_{21}, ab_{22} . . ., ab_{2q} . . ., subject one, treatment ab_{p1}, ab_{p2} . . ., ab_{pq}; next record, subject two, treatments ab_{11}, ab_{12}. . ., ab_{iq} . . ., subject n, treatments ab_{p1}, ab_{p2} . . ., ab_{pq}.) A printout of the raw data file would show q data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (maximum 25)

   b. number of levels of Factor B (maximum 25)

   c. number of subjects (maximum 1000)

   d. name of data file

   e. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the nubmer of subjects necessary for the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, _Experimental Design Procedures for the Behavioral Sciences_, Wadsworth Publishing Company, 1968, Pp. 238-240.

The accuracy of this program is equal to that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences.

```
 RU,AV22
AV22 OR RBF-P,Q    TWO WAY ANOVA WITH REPEATED MEASURES
          OR BLOCKS ON BOTH FACTORS.   INDEX FOR FACTOR B FIRST,
             THEN A AND LAST SUBJECTS.   PROGRAM EXPECTS Q POINTS PER LINE
ENTER DATA FILE NAME
#JRBPQ


 ENTER FORMAT OF DATA
(4(2X,F8.4))
 ENTER 1 FOR CRT, 6 FOR LINE PRINTER OUTPUT
6
 LEVELS OF A
2
 LEVELS OF B
4
 HOW MANY SUBJECTS
4
PRINT OUT OF RAW DATA (1=YES,Ø=NO)
1
:
```

RAW DATA

3.0000	4.0000	7.0000	7.0000
1.0000	2.0000	5.0000	10.0000
6.0000	5.0000	8.0000	8.0000
2.0000	3.0000	6.0000	10.0000
3.0000	4.0000	7.0000	9.0000
2.0000	4.0000	5.0000	9.0000
3.0000	3.0000	6.0000	8.0000
2.0000	3.0000	6.0000	11.0000

CELL		N	SUMX	SUMX2	MEAN	SD
1	1	4	15.000	63.000	3.750	1.500
1	2	4	16.000	66.000	4.000	.816
1	3	4	28.000	198.000	7.000	.816
1	4	4	32.000	258.000	8.000	.816
2	1	4	7.000	13.000	1.750	.500
2	2	4	12.000	38.000	3.000	.816
2	3	4	22.000	122.000	5.500	.577
2	4	4	40.000	402.000	10.000	.816

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	3.125	1	3.125	4.953	.03516
B	194.500	3	64.833	102.755	.00000
AB	19.375	3	6.458	10.236	.00041
RESIDUAL	13.250	21.	.631		
TOTAL	235.500	31.			

```
0001  FTN4,L
0002        PROGRAM AV22
0003        DOUBLE PRECISION ABB(400),SSS(1000),AII(20),BJJ(20),BSS(20),PF3
0004        DOUBLE PRECISION X1(400),X2(400),XR(20),WC1,A1B1,AB2,AF2,BG2
0005        DOUBLE PRECISION X,SY,SX,SA,AS,BS,AF,AB,BG,WC,XH,XB,SD,DW,DI
0006        DOUBLE PRECISION AF3,BG3,AB3,A1,B1,DP,AF1,BG1,AB1,ZEE,PF1,PF2
0007        DIMENSION NFILE(3),IFMT(20),IB(272),IBUF(256)
0008        INTEGER A,B
0009        WRITE(1,4400)
0010  4400  FORMAT("AV22 OR RBF-P,Q   TWO WAY ANOVA WITH REPEATED MEASURES"
0011       &,/,10X,"OR BLOCKS ON BOTH FACTORS.  INDEX FOR FACTOR B FIRST,",
0012       %/,10X," THEN A AND LAST SUBJECTS.  PROGRAM EXPECTS Q POINTS "
0013       &,"PER LINE",/,
0014       C"ENTER DATA FILE NAME")
0015        READ(1,16)NFILE
0016  16    FORMAT(3A2)
0017        IDCBS=256
0018        CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
0019        IF(IER.LT.0)GO TO 999
0020        WRITE(1,4401)
0021  4401  FORMAT ( " ENTER FORMAT OF DATA " )
0022        READ(1,6)IFMT
0023  6     FORMAT(20A2)
0024        WRITE(1,145)
0025  145   FORMAT(" ENTER 1 FOR CRT, 6 FOR LINE PRINTER OUTPUT")
0026        READ(1,*) IUNIT
0027        WRITE(1,4402)
0028  4402  FORMAT ( " LEVELS OF A ")
0029        READ(1,*)  A
0030        WRITE(1,4403)
0031  4403  FORMAT ( " LEVELS OF B ")
0032        READ(1,*)  B
0033        WRITE(1,4404)
0034  4404  FORMAT ( " HOW MANY SUBJECTS ")
0035        READ(1,*)  N
0036        WRITE(1,942)
0037  942   FORMAT("PRINT OUT OF RAW DATA (1=YES,0=NO)?")
0038        READ(1,*) IPTO
0039        DO 250 K=1,N
0040        DO 320 I=1,A
0041        CALL READF(IB,IER,IBUF)
0042        CALL CODE
0043        READ(IBUF,IFMT) (XR(KL),KL=1,B)
0044        IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (XR(J),J=1,B)
0045        DO 430 J=1,B
0046        X=XR(J)
0047        SY=SY+X*X
0048        II=(I-1)*B+J
0049        X1(II)=X1(II)+X
0050        X2(II)=X2(II)+X*X
0051        SX=SX+X
```

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```
0052          II=I+A*(J-1)
0053          ABB(II)=ABB(II)+X
0054          SSS(K)=SSS(K)+X
0055          AII(I)=AII(I)+X
0056          BJJ(J)=BJJ(J)+X
0057          BSS(J)=BSS(J)+X
0058    430   SA=SA+X
0059          AS=AS+SA*SA/B
0060    320   SA=0
0061          DO 250 J=1,B
0062          BS=BS+BSS(J)*BSS(J)/A
0063    250   BSS(J)=0
0064          DO 230 I=1,A
0065          AF=AF+AII(I)*AII(I)/(B*N)
0066          DO 630 J=1,B
0067          II=I+A*(J-1)
0068          AB=AB+ABB(II)*ABB(II)/N
0069    630   CONTINUE
0070    230   CONTINUE
0071          DO 240 J=1,B
0072          BG=BG+BJJ(J)*BJJ(J)/(A*N)
0073    240   CONTINUE
0074          X=0
0075          DO 1450 I=1,N
0076   1450   X=X+SSS(I)*SSS(I)/(A*B)
0077          SX=SX*SX/(A*B*N)
0078          WC=SY+SX-X-AB
0079          SY=SY-SX
0080          AB=AB+SX-AF-BG
0081          AF=AF-SX
0082          BG=BG-SX
0083          WRITE(IUNIT,101)
0084    101   FORMAT(/////,"0 CELL",6X,"N",10X,"SUMX",6X,"SUMX2",8X,
0085         1"MEAN",8X,"SD",/)
0086          XN=N
0087          DO 102 I=1,A
0088          DO 102 J=1,B
0089          II=(I-1)*B+J
0090          XB=X1(II)/XN
0091          SD=DSQRT((X2(II)-(X1(II)*X1(II))/XN)/(XN-1.))
0092    102   WRITE(IUNIT,127) I,J,N,X1(II),X2(II),XB,SD
0093    127   FORMAT(2I3,3X,I4,3X,4(1X,F10.3))
0094          WRITE(IUNIT,810)
0095    810   FORMAT(///,15X,"SOURCE TABLE",//," SOURCE",9X,"SS",8X,"DF",
0096         110X,"MS",10X,"F",11X,"P(F)",/)
0097          DW=(A*B-1)*(N-1)
0098          A=A-1
0099          B=B-1
0100          DI=A*B
0101          WC1=WC
0102          A1B1=(A+1)*(B+1)*N-1
0103          WC=WC/DW
```

```
0104        AB2=AB/DI
0105        AF2=AF/A
0106        BG2=BG/B
0107        AF3=AF2/WC
0108        BG3=BG2/WC
0109        AB3=AB2/WC
0110        A1=A
0111        B1=B
0112        DP=DW
0113        AF1=AF3
0114        BG1=BG3
0115        AB1=AB3
0116        CALL FPROB(AF1,A1,DP,ZEE,PF1)
0117        DP=DW
0118        CALL FPROB(BG1,B1,DP,ZEE,PF2)
0119        DP=DW
0120        CALL FPROB(AB1,DI,DP,ZEE,PF3)
0121        WRITE(IUNIT,820) AF,A,AF2,AF3,PF1,BG,B,BG2,BG3,PF2,AB,DI,AB2,
0122       1AB3,PF3,WC1,DW,WC,SY,A1B1
0123  820   FORMAT(3X,"A",9X,F8.3,5X,I3,2(5X,F8.3),,5X,F8.5,/,
0124       13X,"B",9X,F8.3,5X,I3,2(5X,F8.3),5X,F8.5,/,
0125       22X,"AB",9X,F8.3,5X,I3,2(5X,F8.3),5X,F8.5,/,
0126       32X,"RESIDUAL",X,F10.3,X,F8.0,4X,F8.3,//," TOTAL",7X,F8.3,1X,
0127       4F8.0)
0128        CALL CLOSE(IB,IER)
0129        GO TO 987
0130  999   WRITE(1,4409)
0131  4409  FORMAT (  " ERROR ON CALL OPEN STATEMENT "   )
0132        STOP
0133  987   END
0134        END#
```

AV30   (CRF - P,Q,R)   (Three-way ANOVA)

Purpose:

This program performs a three-way completely randomized factorial analysis of variance without replication.

Mathematical Model:

The model for this design is:

$$X_{ijkm} = u + A_i + B_j = C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + E_{m(ijk)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $C_k = 0$ for all k

Ho: $AB_{ij} = 0$ for all ij

Ho: $AC_{ik} = 0$ for all ik

Ho: $BC_{jk} = 0$ for all jk

Ho: $ABC_{ijk} = 0$ for all ijk

The fixed effect model (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

	B_1		B_2	
	C_1	C_2	C_1	C_2
A_1	S_1	S_2	S_3	S_4
A_2	S_5	S_6	S_7	S_8

S represents a set of subjects

1. There are three Factors (A,B,C) with p, q, and r levels of treatments respectively. The experiment consists of pqr treatment combinations. The above example includes two levels of each of Factors A, B, and C.

2. Subjects are randomly assigned to the pqr treatment combinations with each subject receiving only one combination.

3. There should be more than one subject per pqr treatment combination.

User Considerations and Procedures:

1. A data file must be created with each point in a sequential file indexing for subjects within Factor C fastest, then Factor B, and finally A. (For example, first record is subject one for treatment abc_{111}, second record is subject two for treatment abc_{111}. . ., then subject one for treatment abc_{112}, then subject two for treatment abc_{112} . . ., last record would be subject n for treatment abc_{pqr}.) A printout of the raw data file would show one data point per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by above option (#2).

4. Parameters required:

   a. number of levels of Factor A (maximum 9)

   b. number of levels of Factor B (maximum 9)

   c. number of levels of Factor C (maximum 9)

   d. number of subjects per ABC cell (maximum 32767)

   e. name of data file

   f. format of data file

5. Printout gives:

   a. raw data (optional)

   b. for each cell (treatment combination): N, Σx, Σx^2, $\bar{X}$, and SD (unbiased estimate)

   c. ANOVA course table

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Comments:

Program uses least square analysis for unequal cell sample sizes.
This ANOVA design permits interaction effects to be evaluated. Power
tests can be used to determine the number of subjects necessary for
the experiment.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental
Design Procedures for the Behavioral Sciences, Wadsworth Publishing
Company, 1968, Pp. 218-221.

The accuracy of this program is less than that obtained by the Statistical
Analysis System and Statistical Package for Social Sciences. The data
analysis output is only accurate to five digit places instead of ten
digits.

```
  RU,AV30
AV30 OR CRFPQR
REF: BRUNING & KINTZ, 1968
SECTION 2.3
FACTORIAL DESIGN:  THREE FACTORS
        NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR
               FACTOR C WILL VARY MOST RAPIDLY, INDEX
               FOR FACTOR B VARIES NEXT, THEN INDEX
               FOR FACTOR A VARIES.  PROGRAM EXPECTS
               ALL DATA TO BE IN ONE SEQUENTIAL FILE.
        NOTE:  MAX 9 * 9 * 9 DESIGN
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO
1
ENTER NAME OF INPUT DATA FILE:
#AV20


ENTER INPUT DATA FORMAT:
(4x,F10.4)
ENTER # LEVELS FACTORS A, B, & C:
2,2,2
FACTOR A, LEVEL:            1
FACTOR B, LEVEL:            1
FACTOR C, LEVEL:            1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:            1
FACTOR B, LEVEL:            1
FACTOR C, LEVEL:            2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:            1
FACTOR B, LEVEL:            2
FACTOR C, LEVEL:            1
ENTER ## SS THIS CELL:
4
FACTOR A, LEVEL:            1
FACTOR B, LEVEL:            2
FACTOR C, LEVEL:            2
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:            2
FACTOR B, LEVEL:            1
FACTOR C, LEVEL:            1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:            2
FACTOR B, LEVEL:            1
FACTOR C, LEVEL:            2
ENTER # SS THIS CELL:
4
```

```
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        2
FACTOR C, LEVEL:        1
ENTER # SS THIS CELL:
4
FACTOR A, LEVEL:        2
FACTOR B, LEVEL:        2
FACTOR C, LEVEL:        2
ENTER # SS THIS CELL:
4
:
```

```
LEVEL:      1  1  1   RAW DATA
            3.0000
            6.0000
            3.0000
            3.0000
LEVEL:      1  1  2   RAW DATA
            4.0000
            5.0000
            4.0000
            3.0000
LEVEL:      1  2  1   RAW DATA
            7.0000
            8.0000
            7.0000
            6.0000
LEVEL:      1  2  2   RAW DATA
            7.0000
            8.0000
            9.0000
            8.0000
LEVEL:      2  1  1   RAW DATA
            1.0000
            2.0000
            2.0000
            2.0000
LEVEL:      2  1  2   RAW DATA
            2.0000
            3.0000
            4.0000
            3.0000
LEVEL:      2  2  1   RAW DATA
            5.0000
            6.0000
            5.0000
            6.0000
LEVEL:      2  2  2   RAW DATA
           10.0000
            9.0000
           11.0000
           10.0000
```

CELL			N	SUMX	SUMX2	MEAN	SD
1	1	1	4	15.000	63.000	3.750	1.500
1	1	2	4	16.000	66.000	4.000	.816
1	2	1	4	28.000	198.000	7.000	.816
1	2	2	4	32.000	258.000	8.000	.816
2	1	1	4	7.000	13.000	1.750	.500
2	1	2	4	12.000	38.000	3.000	.816
2	2	1	4	22.000	122.000	5.500	.577
2	2	2	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
FACTOR A	3.125	1.	3.125	4.054	.052693
FACTOR B	162.000	1.	162.000	210.162	.000000
FACTOR C	24.500	1.	24.500	31.784	.000050
A * B	6.125	1.	6.125	7.946	.009279
A * C	10.125	1.	10.125	13.135	.001666
B * C	8.000	1.	3.000	10.378	.003874
A * B * C	3.125	1.	3.125	4.054	.052693
ERROR	18.500	24.	.771		

```
0001   FTN4,L
0002          PROGRAM AV30
0003          DOUBLE PRECISION MSA,MSB,MSC,MSAB,MSAC,MSBC,MSABC,MSER
0004          DOUBLE PRECISION FA,FB,FC,FAB,FAC,FBC,FABC,F,DF1,DF2,Z
0005          DOUBLE PRECISION PA,PB,PC,PAB,PAC,PBC,PABC
0006          DOUBLE PRECISION SX2(8,8,8),XBAR(8,8,8),SD(8,8,8)
0007          DOUBLE PRECISION S2(8,8,8),S6(8),S7(8),S8(8),S9(8,8),S10(8,8),
0008         $S11(8,8),RDATA,TSS,S3,S4,CT,SST,SSA,SSB,SSC,SSAB,SSAC,SSBC,
0009         $SSABC,SSER,DFT,DFA,DFB,DFC,DFAB,DFAC,DFBC,DFABC,DFER
0010          DIMENSION IB(144),IBUF(128),IFMT(20),INFILE(3),NS(8,8,8)
0011          DIMENSION NS6(8),NS7(8),NS8(8),NS9(8,8),NS10(8,8),NS11(8,8)
0012          WRITE(1,4400)
0013   4400   FORMAT ( "AV30 OR CRFPQR" ,/,
0014         C "REF: BRUNING & KINTZ, 1968" ,/,
0015         C "SECTION 2.3"  ,/,
0016         C "FACTORIAL DESIGN:  THREE FACTORS" ,/,
0017         C "     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR" ,/,
0018         C "             FACTOR C WILL VARY MOST RAPIDLY, INDEX" )
0019          WRITE(1,4406)
0020   4406   FORMAT ( "             FOR FACTOR B VARIES NEXT, THEN INDEX" ,/,
0021         C "             FOR FACTOR A VARIES.  PROGRAM EXPECTS"  ,/,
0022         C "             ALL DATA TO BE IN ONE SEQUENTIAL FILE." ,/,
0023         C "     NOTE:  MAX 8 * 8 * 8 DESIGN" )
0024   4975   WRITE(1,4410)
0025   4410   FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
0026          READ(1,*) IUNIT
0027          IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 4975
0028          WRITE(1,4411)
0029   4411   FORMAT ("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO ")
0030          READ(1,*)  IPTO
0031          WRITE(1,4412)
0032   4412   FORMAT ( "ENTER NAME OF INPUT DATA FILE:" )
0033          READ(1,498)INFILE
0034   498    FORMAT(3A2)
0035          IDCBS=128
0036          CALL OPEN (IB,IER,INFILE,3,0,-2,IDCBS)
0037          IF(IER.GE.0)GO TO 4985
0038          WRITE(1,4413) INFILE,IER
0039   4413   FORMAT(5X,3A2,4X,"NO OPEN INPUT DATA FILE, IER = ",I5  )
0040          STOP 4413
0041   4985   WRITE(1,4414)
0042   4414   FORMAT ( "ENTER INPUT DATA FORMAT:" )
0043          READ(1,477)IFMT
0044   477    FORMAT(20A2)
0045          WRITE(1,4415)
0046   4415   FORMAT ( "&ENTER # LEVELS FACTORS A, B, & C: ")
0047          READ(1,*)  NLA,NLB,NLC
0048          DO 500 LA=1,NLA
0049          DO 500 LB=1,NLB
0050          DO 500 LC=1,NLC
0051          WRITE(1,4416) LA
```

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0052  4416   FORMAT ( "FACTOR A, LEVEL: ",I5 )
0053         WRITE(1,4417) LB
0054  4417   FORMAT ( "FACTOR B, LEVEL: ",I5 )
0055         WRITE(1,4418) LC
0056  4418   FORMAT ( "FACTOR C, LEVEL: ",I5 )
0057         WRITE(1,4419)
0058  4419   FORMAT ( "$ENTER # SS THIS CELL: ")
0059         READ(1,*)  NS(LA,LB,LC)
0060         K=NS(LA,LB,LC)
0061         IF(IPTO.EQ.1)WRITE(IUNIT,1)LA,LB,LC
0062  1      FORMAT(" LEVEL:  ",3I3,"  RAW DATA")
0063         DO 499 N=1,K
0064         CALL READF(IB,IER,IBUF)
0065         CALL CODE
0066         READ(IBUF,IFMT)RDATA
0067         IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)RDATA
0068         TSS=TSS+1
0069         S2(LA,LB,LC)=S2(LA,LB,LC)+RDATA
0070         SX2(LA,LB,LC)=SX2(LA,LB,LC)+RDATA**2
0071         S3=S3+RDATA**2
0072         S4=S4+RDATA
0073         S6(LA)=S6(LA)+RDATA
0074         NS6(LA)=NS6(LA)+1
0075         S7(LB)=S7(LB)+RDATA
0076         NS7(LB)=NS7(LB)+1
0077         S8(LC)=S8(LC)+RDATA
0078         NS8(LC)=NS8(LC)+1
0079         S9(LA,LB)=S9(LA,LB)+RDATA
0080         NS9(LA,LB)=NS9(LA,LB)+1
0081         S10(LA,LC)=S10(LA,LC)+RDATA
0082         NS10(LA,LC)=NS10(LA,LC)+1
0083         S11(LB,LC)=S11(LB,LC)+RDATA
0084         NS11(LB,LC)=NS11(LB,LC)+1
0085  499    CONTINUE
0086  500    CONTINUE
0087         DO 501 I1=1,NLA
0088         DO 501 I2=1,NLB
0089         DO 501 I3=1,NLC
0090         ANS=NS(I1,I2,I3)
0091         XBAR(I1,I2,I3)=S2(I1,I2,I3)/ANS
0092         SD(I1,I2,I3)=DSQRT((ANS*SX2(I1,I2,I3)-
0093        $S2(I1,I2,I3)**2)/(ANS*(ANS-1.)))
0094  501    CONTINUE
0095         WRITE(IUNIT,502)(((I1,I2,I3,NS(I1,I2,I3),S2(I1,I2,I3),
0096        $SX2(I1,I2,I3),XBAR(I1,I2,I3),SD(I1,I2,I3),I3=1,NLC),I2=1,NLB),
0097        $I1=1,NLA)
0098  502    FORMAT("0 CELL        N        SUMX        SUMX2        MEAN",
0099        $9X,"SD",/,(3I2,3X,I4,3X,4(1X,F10.3)))
0100         CT=S4**2/TSS
0101         SST=S3-CT
0102         DO 601 LA=1,NLA
0103  601    SSA=SSA+S6(LA)**2/NS6(LA)
0104         SSA=SSA-CT
0105         DO 701 LB=1,NLB
```

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0106   701    SSB=SSB+S7(LB)**2/NS7(LB)
0107          SSB=SSB-CT
0108          DO 801 LC=1,NLC
0109   801    SSC=SSC+S8(LC)**2/NS8(LC)
0110          SSC=SSC-CT
0111          DO 901 LA=1,NLA
0112          DO 901 LB=1,NLB
0113   901    SSAB=SSAB+S9(LA,LB)**2/NS9(LA,LB)
0114          SSAB=SSAB-SSA-SSB-CT
0115          DO 1001 LA=1,NLA
0116          DO 1001 LC=1,NLC
0117   1001   SSAC=SSAC+S10(LA,LC)**2/NS10(LA,LC)
0118          SSAC=SSAC-SSA-SSC-CT
0119          DO 1101 LB=1,NLB
0120          DO 1101 LC=1,NLC
0121   1101   SSBC=SSBC+S11(LB,LC)**2/NS11(LB,LC)
0122          SSBC=SSBC-SSB-SSC-CT
0123          DO 1201 LA=1,NLA
0124          DO 1201 LB=1,NLB
0125          DO 1201 LC=1,NLC
0126   1201   SSABC=SSABC+S2(LA,LB,LC)**2/NS(LA,LB,LC)
0127          SSABC=SSABC-SSA-SSB-SSC-SSAB-SSAC-SSBC-CT
0128          SSER=SST-SSA-SSB-SSC-SSAB-SSAC-SSBC-SSABC
0129          DFT=TSS-1
0130          DFA=NLA-1
0131          DFB=NLB-1
0132          DFC=NLC-1
0133          DFAB=DFA*DFB
0134          DFAC=DFA*DFC
0135          DFBC=DFB*DFC
0136          DFABC=DFA*DFB*DFC
0137          DFER=DFT-DFA-DFB-DFC-DFAB-DFAC-DFBC-DFABC
0138          MSA=SSA/DFA
0139          MSB=SSB/DFB
0140          MSC=SSC/DFC
0141          MSAB=SSAB/DFAB
0142          MSAC=SSAC/DFAC
0143          MSBC=SSBC/DFBC
0144          MSABC=SSABC/DFABC
0145          MSER=SSER/DFER
0146          FA=MSA/MSER
0147          FB=MSB/MSER
0148          FC=MSC/MSER
0149          FAB=MSAB/MSER
0150          FAC=MSAC/MSER
0151          FBC=MSBC/MSER
0152          FABC=MSABC/MSER
0153          F=FA
0154          DF1=DFA
0155          DF2=DFER
0156          CALL FPROB(F,DF1,DF2,Z,PA)
0157          F=FB
0158          DF1=DFB
0159          DF2=DFER
0160          CALL FPROB(F,DF1,DF2,Z,PB)
```

```
0161          F=FC
0162          DF1=DFC
0163          DF2=DFER
0164          CALL FPROB(F,DF1,DF2,Z,PC)
0165          F=FAB
0166          DF1=DFAB
0167          DF2=DFER
0168          CALL FPROB(F,DF1,DF2,Z,PAB)
0169          F=FAC
0170          DF1=DFAC
0171          DF2=DFER
0172          CALL FPROB(F,DF1,DF2,Z,PAC)
0173          F=FBC
0174          DF1=DFBC
0175          DF2=DFER
0176          CALL FPROB(F,DF1,DF2,Z,PBC)
0177          F=FABC
0178          DF1=DFABC
0179          DF2=DFER
0180          CALL FPROB(F,DF1,DF2,Z,PABC)
0181          WRITE(IUNIT,1701)SST,DFT,SSA,DFA,MSA,FA,PA,SSB,DFB,MSB,FB,PB,
0182         $SSC,DFC,MSC,FC,PC,SSAB,DFAB,MSAB,FAB,PAB,SSAC,DFAC,MSAC,FAC,
0183         $PAC,SSBC,DFBC,
0184         $MSBC,FBC,PBC,SSABC,DFABC,MSABC,FABC,PABC,SSER,DFER,MSER
0185    1701  FORMAT(/,3X,"SOURCE",9X,"SS",5X,"DF",6X,"MS",10X,"F",7X,"P"//
0186         $"    TOTAL",5X,F10.3,F5.0/3X,"FACTOR A",2X,F10.3,F5.0,2F10.3,
0187         $F10.6/3X,"FACTOR B",2X,F10.3,F5.0,2F10.3,F10.6/3X,"FACTOR C",
0188         $2X,F10.3,F5.0,2F10.3,F10.6/3X,"A * B",5X,F10.3,F5.0,2F10.3,
0189         $F10.6,/,
0190         $3X,"A * C",5X,F10.3,F5.0,2F10.3,F10.6/3X,"B * C",5X,F10.3,F5.0,
0191         $2F10.3,F10.6/3X,"A * B * C",1X,F10.3,F5.0,2F10.3,F10.6/3X,
0192         $"ERROR",5X,F10.3,F5.0,F10.3)
0193          CALL CLOSE(IB,IER)
0194          END
0195          END$
```

AV31C   (SPF-PQ.R) (Three-way Split Plot ANOVA, One Repeated Measure)

Purpose:

   This program performs a three-way split-plot mixed analysis of vari-
   ance with repeated measures on one factor.

Mathematical Model:

   The model for this design is:

   $$X_{ijkm} = u + A_i + B_j + C_k + AC_{ik} + AB_{ij} + BC_{jk} + ABC_{ijk} + \pi_{m(ij)} +$$

   $$BD_{km(ij)} + E_{o(ijkm)}$$

   The hypotheses to be tested are:

   Ho: $A_i = 0$ for all i
   Ho: $B_j = 0$ for all j
   Ho: $C_k = 0$ for all k
   Ho: $AB_{ij} = 0$ for all ij
   Ho: $AC_{ik} = 0$ for all ik
   Ho: $BC_{jk} = 0$ for all jk
   Ho: $ABC_{ijk} = 0$ for all ijk

   The mixed model (Model III) was assumed in the derivation of the
   expected values of the mean squares.

Layout of Design:

		C_1	C_2	C_3
A_1	B_1	S_1	S_1	S_1
	B_2	S_2	S_2	S_2
A_2	B_i	S_3	S_3	S_3
	B_2	S_4	S_4	S_4

S represents a
set of subjects

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1. There are three Factors (A,B, and C) with p,q,r levels of treatments respectively. Factor A and B are designated as between blocks or nonrepeated measures. Factor C is the within block or repeated measure. The above example includes two levels of Factor A, two levels of Factor B, and three levels of Factor C.

2. Subjects from a common population are randomly assigned to the AB treatments. After this, levels of treatment C are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, index for Factor C first, then B, then subjects, and finally A. (For example, record one contains subject one, cell abc_{111}, abc_{112} $\cdot$ $\cdot$ $\cdot$, abc_{11r}; second record is subject one abc_{121}, abc_{122} $\cdot$ $\cdot$ $\cdot$, abc_{12r}; records continue for subject one until abc_{1q1}, abc_{1q2} $\cdot$ $\cdot$ $\cdot$, abc_{1qr} have been entered. The remaining subjects in Factor A_1 should be entered in the same manner. Repeat the same procedures for subjects in Factor A_p.) A printout of the raw data would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

    a. levels of Factor A (maximum 9)

    b. levels of Factor B (maximum 9)

    c. levels of Factor C (maximum 9)

    d. number of subjects per AB cell (maximum 32767)

    e. name of data file

    f. format of data file

5. Printout gives:

    a. raw data by group (optional)

    b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

    c. ANOVA source table

Comments:

Program uses least squares analysis for unequal AB cell sizes. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within block (Factor C, interactions AC, BC, and ABC) effects are more accurate than estimates of the between-block (Factor A, Factor B, and interaction AB) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV33). However, if equal precision for all treatment effects is desired the average power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested from data in Roger E. Kirk, Experimental Design for the Behavior Sciences, Wadsworth Publishing Company, 1968, Pp. 284-287.

The accuracy of this program is less than that obtained by the Statistical Analysis System and by the Statistical Package for the Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

```
    RU,AV31C
AV31C OR SPF- PQ.R
THREE FACTOR MIXED DESIGN:  REPEATED MEASURES ON ONE FACTOR
     NOTE:   PROGRAM CALCULATORS LEAST SQUARES
             SOLUTION IF UNEQUAL CELL N'S
     NOTE:   ON INPUT DATA READ SEQUENCE, INDEX FOR REPEATED
             MEASURES FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR
             FACTOR B VARIES NEXT, THEN INDEX FOR FACTOR A VARIES.
             PROGRAM EXPECTS ALL DATA TO BE IN ONE MATRIX FILE.
     NOTE:   MAX 9 * 9 * 9 DESIGN.
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , Ø = NO
1
ENTER INPUT DATA FILE NAME:
#AV32
ENTER INPUT DATA FORMAT:
(4(4X,F1Ø.4)`


ENTER # LEVELS FACTOR A:
2
ENTER # LEVELS FACTOR B:
2
ENTER # LEVELS FACTOR C (RPT MS FACTOR):
4
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          1
ENTER # SS THIS CELL:
2
FACTOR A, LEVEL:          1
FACTOR B, LEVEL:          2
ENTER # SS THIS CELL:
2
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          1
ENTER # SS THIS CELL:
2
FACTOR A, LEVEL:          2
FACTOR B, LEVEL:          2
ENTER # SS THIS CELL:
2
:
```

```
LEVEL:     1    1      RAW DATA
        3.0000      4.0000      7.0000      7.0000
        6.0000      5.0000      8.0000      8.0000
LEVEL:     1    2      RAW DATA
        3.0000      4.0000      7.0000      9.0000
        3.0000      3.0000      6.0000      8.0000
LEVEL:     2    1      RAW DATA
        1.0000      2.0000      5.0000     10.0000
        2.0000      3.0000      6.0000     10.0000
LEVEL:     2    2      RAW DATA
        2.0000      4.0000      5.0000      9.0000
        2.0000      3.0000      6.0000     11.0000
```

CELL			N	SUMX	SUMX2	MEAN/	SD
1	1	1	2	9.000	45.000	4.500	2.121
1	1	2	2	9.000	41.000	4.500	.707
1	1	3	2	15.000	113.000	7.500	.707
1	1	4	2	15.000	113.000	7.500	.707
1	2	1	2	6.000	18.000	3.000	.000
1	2	2	2	7.000	25.000	3.500	.707
1	2	3	2	13.000	85.000	6.500	.707
1	2	4	2	17.000	145.000	8.500	.707
2	1	1	2	3.000	5.000	1.500	.707
2	1	2	2	5.000	13.000	2.500	.707
2	1	3	2	11.000	61.000	5.500	.707
2	1	4	2	20.000	200.000	10.000	.000
2	2	1	2	4.000	8.000	2.000	.000
2	2	2	2	7.000	25.000	3.500	.707
2	2	3	2	11.000	61.000	5.500	.707
2	2	4	2	20.000	202.000	10.000	1.414

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN SUBJECTS	12.500	7.			
FACTOR A	3.125	1.	3.125	1.724	.259214
FACTOR B	.125	1.	.125	.069	.799328
A * B	2.000	1.	2.000	1.103	.354230
ERROR B	7.250	4.	1.812		
WITHIN SUBJECTS	223.000	24.			
FACTOR C	194.500	3.	64.833	163.789	.000001
A * C	19.375	3.	6.458	16.316	.000318
B * C	1.375	3.	.458	1.158	.366568
A * B * C	3.000	3.	1.000	2.526	.106246
ERROR W	4.750	12.	.396		

```
0001   FTN4,L
0002          PROGRAM AV31C
0003          DOUBLE PRECISION SX2(8,8,8),SD(8,8,8),XBAR(8,8,8),TSS,S4,S5,
0004       $GT,S9,CT,SST,SSB,SSFA,SSFB,SSAB,ERB,SSU,SSFC,SSAC,SSBC,SSABC,
0005       $ERU,DFT,DFB,DFFA,DFFB,DFAB,DFERB,DFU,DFFC,DFAC,DFBC,DFABC,
0006       $DFERU,FA,FB,FAB,FC,FAC,FBC,FABC,F,DF1,DF2,Z,PA,PB,PAB,PC,
0007       $PAC,PBC,PABC
0008          DOUBLE PRECISION DVEC(8),S2(8),S3(8,8),S10(8),S11(8),S15(8),
0009       $S16(8,8),S17(8,8),S18(8,8,8)
0010          DOUBLE PRECISION MSA,MSB,MSAB,MSERB,MSU,MSC,MSAC,MSBC,MSABC,
0011       CMSERU
0012          DIMENSION MSS(8,8),MS16(8),MS17(8),IFMT(20),IB(272),IBUF(256)
0013          DIMENSION INFILE(3)
0014          WRITE(1,4400)
0015   4400   FORMAT("AV31C OR SPF- PQ.R",/,
0016       C"THREE FACTOR MIXED DESIGN: REPEATED MEASURES ON ONE FACTOR",/,
0017       C"      NOTE:  PROGRAM CALCULATES LEAST SQUARES" ,/,
0018       C"              SOLUTION IF UNEQUAL CELL N'S" ,/,
0019       C"      NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR REPEATED")
0020          WRITE(1,4405)
0021   4405   FORMAT("                MEASURES FACTOR (C) VARIES MOST RAPIDLY, ",
0022       $"INDEX FOR",/,
0023       C"              FACTOR B VARIES NEXT, THEN INDEX FOR FACTOR "
0024       $,"A VARIES.",/,
0025       C"              PROGRAM EXPECTS DATA TO BE IN ONE MATRIX FILE.",/,
0026       C"      NOTE:  MAX 8 * 8 * 8 DESIGN."  )
0027   8975   WRITE(1,4409)
0028   4409   FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
0029          READ(1,*) IUNIT
0030          IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 8975
0031          WRITE(1,4410)
0032   4410   FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO  ")
0033          READ(1,*) IPTO
0034          WRITE(1,4411)
0035   4411   FORMAT ( "&ENTER INPUT DATA FILE NAME:" )
0036          READ(1,898)IFILE
0037   898    FORMAT(3A2)
0038          WRITE(1,4412)
0039   4412   FORMAT ( "&ENTER INPUT DATA FORMAT:"  )
0040          READ(1,876)IFMT
0041   876    FORMAT(20A2)
0042          IDCBS=256
0043          CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0044          IF(IER.GE.0) GO TO 908
0045          WRITE(1,564) INFILE,IER
0046   564    FORMAT(5X,3A2," FAILED TO OPEN , IER = ",I5)
0047          STOP 564
0048   908    WRITE(1,4413)
0049   4413   FORMAT ( "ENTER # LEVELS FACTOR A: ")
0050          READ(1,*)  NLBA
0051          WRITE(1,4414)
```

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0052  4414    FORMAT ( "ENTER # LEVELS FACTOR B: ")
0053          READ(1,*)  NLBB
0054          WRITE(1,4415)
0055  4415    FORMAT ( "ENTER # LEVELS FACTOR C (RPT MS FACTOR): ")
0056          READ(1,*)  NLW
0057          DO 900 LA=1,NLBA
0058          DO 900 LB=1,NLBB
0059          WRITE(1,4416) LA
0060  4416    FORMAT ( "&FACTOR A, LEVEL: ",I5   )
0061          WRITE(1,4417) LB
0062  4417    FORMAT ( "&FACTOR B, LEVEL: ",I5   )
0063          WRITE(1,4418)
0064  4418    FORMAT ( "&ENTER # SS THIS CELL: ")
0065          READ(1,*)  NSS(LA,LB)
0066          NS=NSS(LA,LB)
0067          TSS=TSS+NS
0068          NS16(LA)=NS16(LA)+NSS(LA,LB)
0069          NS17(LB)=NS17(LB)+NSS(LA,LB)
0070          IF(IPTO.EQ.1)WRITE(IUNIT,1)LA,LB
0071  1       FORMAT(" LEVEL:  ",2I4,"      RAW DATA")
0072          DO 900 N=1,NS
0073          S4=0
0074          CALL READF(IB,IER,IBUF)
0075          CALL CODE
0076          READ(IBUF,IFMT)(DVEC(IXW),IXW=1,NLW)
0077          IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)(DVEC(IXW),IXW=1,NLW)
0078          DO 899 LW=1,NLW
0079          S2(LW)=S2(LW)+DVEC(LW)
0080          S3(LA,LB)=S3(LA,LB)+DVEC(LW)
0081          S4=S4+DVEC(LW)
0082          S5=S5+DVEC(LW)**2
0083          S10(LA)=S10(LA)+DVEC(LW)
0084          S11(LB)=S11(LB)+DVEC(LW)
0085          S15(LW)=S15(LW)+DVEC(LW)
0086          S16(LA,LW)=S16(LA,LW)+DVEC(LW)
0087          S17(LB,LW)=S17(LB,LW)+DVEC(LW)
0088          S18(LA,LB,LW)=S18(LA,LB,LW)+DVEC(LW)
0089          SX2(LA,LB,LW)=SX2(LA,LB,LW)+DVEC(LW)**2
0090  899     CONTINUE
0091          GT=GT+S4
0092          S9=S9+S4**2/NLW
0093  900     CONTINUE
0094          DO 8994 IX1=1,NLBA
0095          DO 8994 IX2=1,NLBB
0096          DO 8994 IX3=1,NLW
0097          ANS=NSS(IX1,IX2)
0098          XBAR(IX1,IX2,IX3)=S18(IX1,IX2,IX3)/ANS
0099          SD(IX1,IX2,IX3)=DSQRT((ANS*SX2(IX1,IX2,IX3)-
0100         $S18(IX1,IX2,IX3)**2)/(ANS*(ANS-1.)))
0101  8994    CONTINUE
0102          WRITE(IUNIT,8995)(((IX1,IX2,IX3,NSS(IX1,IX2),S18(IX1,IX2,IX3),
0103         $SX2(IX1,IX2,IX3),XBAR(IX1,IX2,IX3),SD(IX1,IX2,IX3),IX3=1,NLW),
0104         $IX2=1,NLBB),IX1=1,NLBA)
```

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```
0105   8995    FORMAT("0 CELL          N          SUMX       SUMX2          MEAN",
0106           $"              SD"/,(3I2,3X,I4,3X,4(1X,F10.3)))
0107           CT=GT**2/(TSS*NLW)
0108           SST=85-CT
0109           SSB=89-CT
0110           DO 1000 LA=1,NLBA
0111   1000    SSFA=SSFA+S10(LA)**2/(NS16(LA)*NLW)
0112           SSFA=SSFA-CT
0113           DO 1100 LB=1,NLBB
0114   1100    SSFB=SSFB+S11(LB)**2/(NS17(LB)*NLW)
0115           SSFB=SSFB-CT
0116           DO 1299 LA=1,NLBA
0117           DO 1299 LB=1,NLBB
0118   1299    SSAB=SSAB+S3(LA,LB)**2/(NSS(LA,LB)*NLW)
0119           SSAB=SSAB-SSFA-SSFB-CT
0120   1300    ERB=SSB-SSFA-SSFB-SSAB
0121   1400    SSW=SST-SSB
0122           DO 1599 LW=1,NLW
0123   1599    SSFC=SSFC+S15(LW)**2/TSS
0124           SSFC=SSFC-CT
0125           SSAC=0
0126           DO 1699 LA=1,NLBA
0127           DO 1699 LW=1,NLW
0128   1699    SSAC=SSAC+S16(LA,LW)**2/NS16(LA)
0129           SSAC=SSAC-SSFA-SSFC-CT
0130           DO 1799 LB=1,NLBB
0131           DO 1799 LW=1,NLW
0132   1799    SSBC=SSBC+S17(LB,LW)**2/NS17(LB)
0133           SSBC=SSBC-SSFB-SSFC-CT
0134           DO 1899 LA=1,NLBA
0135           DO 1899 LB=1,NLBB
0136           DO 1899 LW=1,NLW
0137   1899    SSABC=SSABC+S18(LA,LB,LW)**2/NSS(LA,LB)
0138           SSABC=SSABC-SSFA-SSFB-SSAB-SSFC-SSAC-SSBC-CT
0139           ERW=SSW-SSFC-SSAC-SSBC-SSABC
0140           DFT=TSS*NLW-1
0141           DFB=TSS-1
0142           DFFA=NLBA-1
0143           DFFB=NLBB-1
0144           DFAB=DFFA*DFFB
0145           DFERB=DFB-DFFA-DFFB-DFAB
0146           DFW=DFT-DFB
0147           DFFC=NLW-1
0148           DFAC=DFFC*DFFA
0149           DFBC=DFFC*DFFB
0150           DFABC=DFFA*DFFB*DFFC
0151           DFERW=DFW-DFFC-DFAC-DFBC-DFABC
0152           MSA=SSFA/DFFA
0153           MSB=SSFB/DFFB
0154           MSAB=SSAB/DFAB
0155           MSERB=ERB/DFERB
0156           MSW=SSW/DFW
0157           MSC=SSFC/DFFC
0158           MSAC=SSAC/DFAC
0159           MSBC=SSBC/DFBC
0160           MSABC=SSABC/DFABC
0161           MSERW=ERW/DFERW
```

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```
0162      FA=MSA/MSERB
0163      FB=MSB/MSERB
0164      FAB=MSAB/MSERB
0165      FC=MSC/MSERW
0166      FAC=MSAC/MSERW
0167      FBC=MSBC/MSERW
0168      FABC=MSABC/MSERW
0169      F=FA
0170      DF1=DFFA
0171      DF2=DFERB
0172      CALL FPROB(F,DF1,DF2,Z,PA)
0173      F=FB
0174      DF1=DFFB
0175      DF2=DFERB
0176      CALL FPROB(F,DF1,DF2,Z,PB)
0177      F=FAB
0178      DF1=DFAB
0179      DF2=DFERB
0180      CALL FPROB(F,DF1,DF2,Z,PAB)
0181      F=FC
0182      DF1=DFFC
0183      DF2=DFERW
0184      CALL FPROB(F,DF1,DF2,Z,PC)
0185      F=FAC
0186      DF1=DFAC
0187      DF2=DFERW
0188      CALL FPROB(F,DF1,DF2,Z,PAC)
0189      F=FBC
0190      DF1=DFBC
0191      DF2=DFERW
0192      CALL FPROB(F,DF1,DF2,Z,PBC)
0193      F=FABC
0194      DF1=DFABC
0195      DF2=DFERW
0196      CALL FPROB(F,DF1,DF2,Z,PABC)
0197      WRITE(IUNIT,2201)SST,DFT,SSB,DFB,SSFA,DFFA,MSA,FA,PA,SSFB,DFFB,
0198     $MSB,FB,PB,SSAB,DFAB,MSAB,FAB,PAB,ERB,DFERB,MSERB,SSW,DFW,SSFC,
0199     $DFFC,MSC,FC,PC,SSAC,DFAC,MSAC,FAC,PAC,SSBC,DFBC,MSBC,FBC,PBC,
0200     $SSABC,DFABC,MSABC,FABC,PABC,ERW,DFERW,MSERW
0201 2201 FORMAT("0",8X,"SOURCE",11X,"SS",5X,"DF",5X,"MS",9X,"F",11X,"P"
0202     $//" TOTAL",14X,F10.3,F5.0/"    BETWEEN SUBJECTS ",F10.3,F5.0/5X,
0203     $"FACTOR A",7X,F10.3,F5.0,2F10.3,F12.6/5X,"FACTOR B",7X,F10.3, 4
0204     $F5.0,2F10.3,F12.6/5X,"A * B",10X,F10.3,F5.0,2F10.3,F12.6/7X,
0205     $"ERROR B",6X,F10.3,
0206     $F5.0,F10.3//"    WITHIN SUBJECTS",2X,F10.3,F5.0/5X,"FACTOR C",
0207     $7X,F10.3,F5.0,2F10.3,F12.6/5X,"A * C",10X,F10.3,F5.0,2F10.3,
0208     $F12.6/,5X,"B * C",10X,F10.3,F5.0,2F10.3,F12.6,/,5X,"A * B * C"
0209     $,6X,F10.3,F5.0,2F10.3,F12.6,/,7X,"ERROR W",6X,F10.3,F5.0,F10.3)
0210      CALL CLOSE (IB,IER)
0211      END
0212      END$
```

AV32BC   (SPF-P.QR)   (Three-way Split Plot ANOVA, Two Repeated Measures)

Purpose:

This program performs a three-way mixed split plot analysis of variance with repeated measures on two factors.

Mathematical Model:

The model for this design is:

$$X_{ijkm} = u + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + \pi_{m(i)} +$$

$$B\pi_{jm(i)} + C\pi_{cm(i)} + BC\pi_{jkm(i)} + E_{o(ijkm)}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $C_k = 0$ for all k

Ho: $AB_{ijk} = 0$ for all ij

Ho: $AC_{ik} = 0$ for all ik

Ho: $BC_{jk} = 0$ for all jk

Ho: $ABC_{ijk} = 0$ for all ijk

The mixed model (Model III) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

	B_1		B_2	
	C_1	C_2	C_1	C_2
A_1	S_1	S_1	S_1	S_1
A_2	S_2	S_2	S_2	S_2

S represents a set of subjects

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1. There are three Factors (A,B, and C) with p, q, r levels of treatment respectively. Factor A is designated as the between block or nonrepeated measure. Factors B and C are the within blocks or repeated measures. The above example includes two levels each of Factors A, B, and C.

2. Subjects from a common population are randomly assigned to the levels of Factor A. After this, levels of treatments B and C are assigned randomly to the subjects except when the nature of the repeated measure precludes randomization of the presentation order.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor C indexes first, then B, then subjects and finally A. (For example, record one contains subject one, cell abc_{111}, abc_{112} . . ., abc_{11r}, abc_{121}, abc_{122} . . ., abc_{12r} . . ., abc_{1q1}, abc_{1q2} . . ., abc_{1qr}; the next record contains the same information for subject two. The remaining subjects in Factor A_1 should be entered in the same manner. Repeat the same procedure for subjects in A_p.) A printout of the raw data would show qr data points.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. levels of Factor A (maximum 11)

   b. levels of Factor B (maximum 11)

   c. levels of Factor C (or groups) (maximum 11)

   d. number of subjects per group (maximum 32767)

   e. data file name

   f. format of data file

5. Printout gives:

    a. raw data by group (optional)

    b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

    c. ANOVA source table

Comments:

Program uses least squares analysis for unequal cell sizes on Factor A. This ANOVA design permits interaction effects to be evaluated. In a split-plot design, estimates of the within-block (Factor B, Factor C, interactions AB, AC, BC, and ABC) effects are more accurate than estimates of between-block (Factor A) effects. If an experimenter's primary interest is in the within-block effects, a split-plot design is more powerful than a randomized factorial block design (AV33). However, if equal precision for all treatment effects is desired, the average power of a randomized factorial block design is greater. Power tests can be used to determine the number of subjects necessary for the experiment.

Test Data:

This program was tested from data in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 298-302.

The accuracy of this program is less than that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

```
  RU,AV32
AV32AB OR SPF P.QR
REF:  BRUNING & KINTZ, 1968
SECTION 2.9
THREE-FACTOR MIXED DESIGN:  REPEATED MEASURES ON TWO FACTORS
     NOTE:  PROGRAM CALCULATES LEAST SQUARES
            SOLUTION IF UNEQUAL CELL N's
     NOTE:  ON INPUT DATA READ SEQUENCE, INDEX FOR 2ND WITHIN
            FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR 1ST WITHIN
            FACTOR (B) VARIES NEXT, THEN INDEX FOR THE BETWEEN
            FACTOR (A) VARIES.  PROGRAM EXPECTS ALL DATA TO
            BE IN ONE MATRIX FILE.
     NOTE:  MAX 11 * 11 * 11 DESIGN.
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
 DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO
1
ENTER INPUT FILE NAME:
#AV32


ENTER INPUT DATA FORMAT:
(4(4X,F10.4))
ENTER # OF LEVELS ON FACTORS B & C, AND # OF GROUPS:
2,2,2
ENTER GP # AND # SS IN GROUP:
1,4
ENTER GP # AND # SS IN GROUP:
2,4
  AV32   :  STOP    0000
  :
```

```
GROUP:          1      RAW DATA
        3.0000      4.0000      7.0000      7.0000
        6.0000      5.0000      8.0000      8.0000
        3.0000      4.0000      7.0000      9.0000
        3.0000      3.0000      6.0000      8.0000
GROUP:          2      RAW DATA
        1.0000      2.0000      5.0000     10.0000
        2.0000      3.0000      6.0000     10.0000
        2.0000      4.0000      5.0000      9.0000
        2.0000      3.0000      6.0000     11.0000
```

CELL			N	SUMX	SUMX2	MEAN	SD
1	1	1	4	15.000	63.000	3.750	1.500
1	1	2	4	16.000	66.000	4.000	.816
1	2	1	4	28.000	198.000	7.000	.816
1	2	2	4	32.000	258.000	8.000	.816
2	1	1	4	7.000	13.000	1.750	.500
2	1	2	4	12.000	38.000	3.000	.816
2	2	1	4	22.000	122.000	5.500	.577
2	2	2	4	40.000	402.000	10.000	.816

SOURCE	SS	DF	MS	F	P
TOTAL	235.500	31.			
BETWEEN SUBJECTS	12.500	7.			
GROUPS (A)	3.125	1.	3.125	2 000	.205762
ERROR (A)	9.375	6.	1.562		
WITHIN SUBJECTS	223.000	24.			
FACTOR B	162.000	1.	162.000	199.385	.000095
FACTOR C	24.500	1.	24.500	61.895	.000521
A * B	6.125	1.	6.125	7.538	.032735
A * C	10.125	1.	10.125	25.579	.002835
B * C	8.000	1.	8.000	25.600	.002831
A * B * C	3.125	1.	3.125	10.000	.019275
ERROR (B)	4.875	6.	.813		
ERROR (C)	2.375	6.	.396		
ERROR (BC)	1.375	6.	.313		

```
0001   FTN4,L
0002          PROGRAM AV32B
0003   C THISPROGRAM NAME USED TO BE AV32BC BUT NAME WAS TO LONG
0004          DOUBLE PRECISION MSGPS,MSERB,MSA,MSB,MSAXC,MSBXC,MSAXB,MSABC,
0005   $MSER1,MSER2,MSER3,C,A,B,AC,BC,AB,ABC,F,DF1,DF2,PC,PA,PB,PAC,
0006   $PBC,PAB,PBC,PABC,TSS,SUM8,SUM4,SUM3,SUM18B,SUM8B,SUM19B,XBAR,
0007   $SD,CT,SST,SUM7B,SSGPS,SSB,SSERRB,SSW,SSFA,SSFB,SSAXC,SSBXC,
0008   $SSAXB,SSABC,SSEWS,SSER1,SSER2,SSER3,DFT,DFB,DFGPS,DFERB,DFW,
0009   $DFFA,DFFB,DFAXC,DFBXC,DFAXB,DFABC,DFERRW,DFER1,DFER2,DFER3
0010          DOUBLE PRECISION SX2(8,8,8),DMTRX(8,8),
0011   $SUM18(8),SUM19(8),SUM2(8,8,8),SUM11(8),SUM12(8),
0012   $SUM13(8,8),SUM14(8,8),SUM15(8,8),SUM7A(8)
0013          DIMENSION INFILE(3),IFMT(20),IB(272),IBUF(256),NSS(10)
0014          WRITE(1,4400)
0015   4400   FORMAT ( "AV32BC OR SPF P.QR",/,
0016          C"REF:  BRUNING & KINTZ, 1968"  ,/,
0017          C"SECTION 2.9"  ,/,
0018          C"THREE-FACTOR MIXED DESIGN:REPEATED MEASURES ON TWO FACTORS",/,
0019          C"      NOTE:  PROGRAM CALCULATES LEAST SQUARES" ,/,
0020          C"             SOLUTION IF UNEQUAL CELL N'S" )
0021          WRITE(1,4406)
0022   4406   FORMAT(" NOTE:ON INPUT DATA READ SEQUENCE, INDEX FOR 2ND "
0023          $,"WITHIN",/,
0024          C"      FACTOR (C) VARIES MOST RAPIDLY, INDEX FOR 1ST WITHIN",/,
0025          C"      FACTOR (B) VARIES NEXT, THEN INDEX FOR THE BETWEEN",/,
0026          C"      FACTOR (A) VARIES.  PROGRAM EXPECTS ALL DATA TO",/,
0027          C"      BE IN ONE MATRIX FILE." ,/,
0028          C"      NOTE:  MAX 8 * 8 * 8 DESIGN" )
0029          WRITE(1,4412)
0030   4412   FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
0031          READ(1,*) IUNIT
0032          WRITE(1,4413)
0033   4413   FORMAT("DO YOU WANT PRINTOUT OF RAW DATA 1 = YES , 0 = NO   ")
0034          READ(1,*) IPTO
0035          WRITE(1,4414)
0036   4414   FORMAT ( "&ENTER INPUT FILENAME: "  )
0037          READ(1,1005)INFILE
0038   1005   FORMAT(3A2)
0039          IDCBS=256
0040          WRITE(1,4415)
0041   4415   FORMAT ( "&ENTER INPUT DATA FORMAT:"  )
0042          READ(1,1001)IFMT
0043   1001   FORMAT(20A2)
0044          CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0045          IF(IER.GE.0) GO TO 234
0046          WRITE(1,546) INFILE,IER
0047   546    FORMAT(5X,3A2,5X," FAILED TO OPEN , IER = ",I5)
0048          STOP 546
```

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0049   234    WRITE(1 1416)
0050   4416   FORMAT("&ENTER # OF LEVELS ON FACTORS B & C, AND # OF GROUPS:")
0051          READ(1,*) NLF1R,NLF2R,NGPS
0052          DO 60 I3=1,NGPS
0053          WRITE(1,4417)
0054   4417   FORMAT ( "&ENTER GP # AND # SS IN GROUP: ")
0055          READ(1,*)  NG ISS(NG)
0056          IF(IPTO.EQ.1) WRITE(IUNIT,2) NG
0057   2      FORMAT("  GROUP:    ",I4,"     RAW DATA")
0058          K=NSS(NG)
0059          DO 60 N=1,K
0060          SUM8=0
0061          DO 57 I1=1,8
0062          SUM18(I1)=0
0063          SUM19(I1)=0
0064   57     CONTINUE
0065          CALL READF(IB,IER,IBUF)
0066          CALL CODE
0067          READ(IBUF,IFMT)((DMTRX(I1,I2),I2=1,NLF2R),I1=1,NLF1R)
0068          IF(IPTO.EQ.1)WRITE(IUNIT,IFMT)((DMTRX(I1,I2),I2=1,NLF2R),
0069         $I1=1,NLF1R)
0070          TSS=TSS+1.
0071          DO 59 I1=1,NLF1R
0072          DO 58 I2=1,NLF2R
0073          SUM8=SUM8+DMTRX(I1,I2)
0074          SUM18(I1)=SUM18(I1)+DMTRX(I1,I2)
0075          SUM19(I2)=SUM19(I2)+DMTRX(I1,I2)
0076          SUM2(I1,I2,NG)=SUM2(I1,I2,NG)+DMTRX(I1,I2)
0077          SUM4=SUM4+DMTRX(I1,I2)
0078          SUM3=SUM3+DMTRX(I1,I2)**2
0079          SX2(I1,I2,NG)=SX2(I1,I2,NG)+DMTRX(I1,I2)**2
0080   58     CONTINUE
0081          SUM18B=SUM18B+SUM18(I1)**2/NLF2R
0082   59     CONTINUE
0083          SUM8B=SUM8B+SUM8**2
0084          DO 11 I2=1,NLF2R
0085          SUM19B=SUM19B+SUM19(I2)**2/NL 1R
0086   11     CONTINUE
0087   60     CONTINUE
0088          WRITE(IUNIT,605)
0089   605    FORMAT("0 CELL        N        SUMX       SUMX2       MEAN"
0090         $,"       SD")
0091          DO 61 I3=1,NGPS
0092          DO 61 I1=1,NLF1R
0093          DO 61 I2=1,NLF2R
0094          ANS=NSS(I3)
0095          XBAR=SUM2(I1,I2,I3)/ANS
0096          SD=DSQRT((ANS*SX2(I1,I2,I3)-(SUM2(I1,I2,I3)**2))/
0097         X(ANS*(ANS-1.)))
0098          WRITE(IUNIT,606)I3,I1,I2,NSS(I3),SUM2(I1,I2,I3),
0099         $SX2(I1,I2,I3),XBAR,SD
0100   606    FORMAT(3I2,3X,I4,3X,4(1X,F10.3))
0101   61     CONTINUE
0102          CT=SUM4**2/(TSS*NLF1R*NLF2R)
0103          SST=SUM3-CT
0104          DO 79 I1=1,NGPS
0105          DO 73 I2=1,NLF1R
0106          DO 73 I3=1,NLF2R
```

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```
0107          SUM7A(I1)=SUM7A(I1)+SUM2(I2,I3,I1)
0108          SUM11(I2)=SUM11(I2)+SUM2(I2,I3,I1)
0109          SUM12(I3)=SUM12(I3)+SUM2(I2,I3,I1)
0110          SUM13(I2,I1)=SUM13(I2,I1)+SUM2(I2,I3,I1)
0111          SUM14(I3,I1)=SUM14(I3,I1)+SUM2(I2,I3,I1)
0112          SUM15(I2,I3)=SUM15(I2,I3)+SUM2(I2,I3,I1)
0113          SUM2(I2,I3,I1)=SUM2(I2,I3,I1)**2
0114   78     CONTINUE
0115          SUM7B=SUM7B+(SUM7A(I1)**2/(HSS(I1)*(NLF1R*NLF2R)))
0116   79     CONTINUE
0117          SSGPS=SUM7B-CT
0118          SSB=SUM8B/(NLF1R*NLF2R)-CT
0119          SSERRB=SSB-SSGPS
0120          SSW=SST-SSB
0121          DO 119 I1=1,NLF1R
0122   119    SSFA=SSFA+SUM11(I1)**2/(TSS*NLF2R)
0123          SSFA=SSFA-CT
0124          DO 129 I1=1,NLF2R
0125   129    SSFB=SSFB+SUM12(I1)**2/(TSS*NLF1R)
0126          SSFB=SSFB-CT
0127          DO 139 I1=1,NLF1R
0128          DO 139 I2=1,NGPS
0129   139    SSAXC=SSAXC+SUM13(I1,I2)**2/(HSS(I2)*NLF2R)
0130          SSAXC=SSAXC-SSGPS-SSFA-CT
0131          DO 149 I1=1,NLF2R
0132          DO 149 I2=1,NGPS
0133   149    SSBXC=SSBXC+SUM14(I1,I2)**2/(HSS(I2)*NLF1R)
0134          SSBXC=SSBXC-SSGPS-SSFB-CT
0135          DO 159 I1=1,NLF1R
0136          DO 159 I2=1,NLF2R
0137   159    SSAXB=SSAXB+SUM15(I1,I2)**2/TSS
0138          SSAXB=SSAXB-SSFA-SSFB-CT
0139          DO 169 I1=1,NLF1R
0140          DO 169 I2=1,NLF2R
0141          DO 169 I3=1,NGPS
0142   169    SSABC=SSABC+SUM2(I1,I2,I3)/HSS(I3)
0143          SSABC=SSABC-SSGPS-SSFA-SSFB-SSAXC-SSBXC-SSAXB-CT
0144          SSEWS=SSW-SSFA-SSFB-SSAXC-SSBXC-SSAXB-SSABC
0145          SSER1=SUM18B-SSB-SSFA-SSAXC-CT
0146          SSER2=SUM19B-SSB-SSFB-SSBXC-CT
0147          SSER3=SSEWS-SSER1-SSER2
0148          DFT=TSS*NLF1R*NLF2R-1.
0149          DFB=TSS-1.
0150          DFGPS=NGPS-1.
0151          DFERB=DFB-DFGPS
0152          DFW=DFT-DFB
0153          DFFA=NLF1R-1.
0154          DFFB=NLF2R-1.
0155          DFAXC=DFGPS*DFFA
0156          DFBXC=DFGPS*DFFB
0157          DFAXB=DFFA*DFFB
0158          DFABC=DFFA*DFFB*DFGPS
0159          DFERRW=DFW-DFFA-DFFB-DFAXC-DFBXC-DFAXB-DFABC
0160          DO 219 I1=1,NGPS
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0161        DFER1=DFER1+DFFA*(NSS(I1)-1)
0162        DFER2=DFER2+DFFB*(NSS(I1)-1)
0163        DFER3=DFER3+DFFA*DFFB*(NSS(I1)-1)
0164   219  CONTINUE
0165        MSGPS=SSGPS/DFGPS
0166        MSERB=SSERRB/DFERB
0167        MSA=SSFA/DFFA
0168        MSB=SSFB/DFFB
0169        MSAXC=SSAXC/DFAXC
0170        MSBXC=SSBXC/DFBXC
0171        MSAXB=SSAXB/DFAXB
0172        MSABC=SSABC/DFABC
0173        MSER1=SSER1/DFER1
0174        MSER2=SSER2/DFER2
0175        MSER3=SSER3/DFER3
0176        C=MSGPS/MSERB
0177        A=MSA/MSER1
0178        B=MSB/MSER2
0179        AC=MSAXC/MSER1
0180        BC=MSBXC/MSER2
0181        AB=MSAXB/MSER3
0182        ABC=MSABC/MSER3
0183        F=C
0184        DF1=DFGPS
0185        DF2=DFERB
0186        CALL FPROB(F,DF1,DF2,Z,PC)
0187        F=A
0188        DF1=DFFA
0189        DF2=DFER1
0190        C   L FPROB(F,DF1,DF2,Z,PA)
0191        F=B
0192        DF1=DFFB
0193        DF2=DFER2
0194        CALL FPROB(F,DF1,DF2,Z,PB)
0195        F=AC
0196        DF1=DFAXC
0197        DF2=DFER1
0198        CALL FPROB(F,DF1,DF2,Z,PAC)
0199        F=BC
0200        DF1=DFBXC
0201        DF2=DFER2
0202        CALL FPROB(F,DF1,DF2,Z,PBC)
0203        F=AB
0204        DF1=DFAXB
0205        DF2=DFER3
0206        CALL FPROB(F,DF1,DF2,Z,PAB)
0207        F=ABC
0208        DF1=DFABC
0209        DF2=DFER3
0210        CALL FPROB(F,DF1,DF2,Z,PABC)
0211        WRITE(IUNIT,1004)
0212   1004 FORMAT('0***** SOURCE *****',5X,'SS',6X,'DF',9X,'MS',10X,'F',
0213       $7X,'P'/)
```

```
0214        WRITE(IUNIT,1003) SST,DFT,SSB,DFB,SSGPS,DFGPS,MSGPS,
0215       $C,PC,SSERRB,DFERB,MSERB,SSW,DFW,SSFA,DFFA,MSA,A,PA,
0216       $SSFB,DFFB,MSB,B,PB,SSAXC,DFAXC,MSAXC,AC,PAC,SSBXC,DFBXC,
0217       $MSBXC,BC,PBC,SSAXB,DFAXB,MSAXB,AB,PAB,SSABC,DFABC,MSABC,ABC,
0218       $PABC,SSER1,DFER1,MSER1,SSER2,DFER2,MSER2,SSER3,DFER3,MSER3
0219  1003  FORMAT("0TOTAL",14X,F10.3,F5.0/"   BETWEEN SUBJECTS",F11.3,
0220       $F5./5X,"GROUPS (A)",5X,F10.3,F5.,4X,2F10.3,F10.6/7X,"ERROR(A)"
0221       $,5X,F10.3,F5.,4X,F10.3,/"0   WITHIN SUBJECTS",2X,F10.3,F5.,/5X,
0222       $"FACTOR B",7X,F10.3,F5.,4X,2F10.3,F10.6,/5X,"FACTOR C",7X,
0223       $F10.3,
0224       $F5.,4X,2F10.3,F10.6,/5X,"A X B",10X,F10.3,F5.,4X,2F10.3,F10.6,
0225       $/5X,"A X C",10X,F10.3,F5.,4X,2F10.3,F10.6,/5X,"B X C",10X,
0226       $F10.3,
0227       $F5.,4X,2F10.3,F10.6,/5X,"A X B X C ",5X,F10.3,F5.,4X,2F10.3,
0228       $F10.6,/,7X,"ERROR (B)",4X,F10.3,F5.0,4X,F10.3,/7X,"ERROR (C)"
0229       $,4X
0230       $,F10.3,F5.,4X,F10.3,/,7X,"ERROR (BC)",3X,F10.3,F5.,4X,F10.3)
0231        CALL CLOSE(IB)
0232        STOP
0233        END
0234        END$
```

AV33   (RBF-P,Q,R) (Three-way ANOVA, Repeated Measures)

Purpose:

This program performs a three-way randomized factorial block analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ijm} = u + A_i + B_j + C_k + AB_{ij} + AC_{ik} + BC_{jk} + ABC_{ijk} + \tau_m + E_{ijkm}$$

The hypotheses to be tested are:

Ho: $A_i = 0$ for all i

Ho: $B_j = 0$ for all j

Ho: $C_k = 0$ for all k

Ho: $AB_{ij} = 0$ for all ij

Ho: $AC_{ik} = 0$ for all ik

Ho: $BC_{jk} = 0$ for all jk

Ho: $ABC_{ijk} = 0$ for all ijk

The fixed effect (Model I) was assumed in the derivation of the expected values of the mean squares.

Layout of Design:

A_1				A_2			
B_1		B_2		B_1		B_2	
C_1	C_2	C_1	C_2	C_1	C_2	C_1	C_2
S_1	S_1	S_1	S_1	S_1	S_1	S_1	S_1

S represents a set of subjects

1. There are two Factors (A, B, C) with p, q, and r levels of treatments, respectively. The experiment consists of pqr treatment combinations. The above example includes two levels of each of Factors A, B, and C.

2. Subjects are randomly assigned to the pqr treatment combinations with each subject or a set of matched subjects receiving all combinations. The order of administration of the pqr combination is randomized independently for each subject. If sets of matched subjects are used, one subject from each set is randomly assigned to each treatment combination.

3. There should be more than one subject per pqr treatment combination.

User Considerations and Procedures:

1. A data file must be created in matrix form. On read input, Factor C varies most rapidly, then Factor B, then subjects, and finally Factor A. (For example, record one contains subject one, treatments abc_{111}, abc_{112} . . ., abc_{11r}; record two contains subject one, treatments abc_{121}, abc_{122} . . ., abc_{12r}; records continue for subject one until abc_{1q1}, abc_{1q2} . . ., abc_{1qr} have been entered. The remaining subjects in Factor A should be entered in the same manner. Repeat the same procedures for subjects in Factor A_p. A printout of the raw data would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (see comments)

   b. number of levels of Factor B (see comments)

   c. number of levels of Factor C (see comments)

   d. number of subjects per cell (treatment combination) (see comments)

   e. name of data file

   f. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σx, Σx^2, $\overline{X}$, and SD (unbiased estimate)

   c. ANOVA source table

Comments:

   This ANOVA design permits interaction effects to be evaluated. Power tests can be used to determine the number of subjects necessary for the experiment.

   Due to the limited amount of memory, the experimental design cannot exceed the following conditions:

   1. $p \leqslant 10$; $q \leqslant 10$; $r \leqslant 10$

   2. $n \leqslant 50$

   3. $nqr \leqslant 1000$

   4. $rn \leqslant 100$

   5. $qn \leqslant 100$

Test Data:

   This program was tested using data from Roger E. Kirk, _Experimental Design Procedures for the Behavioral Sciences_, Wadsworth Publishing Company, 1968, Pp. 239-240.

   Single precision was used for this program. Accuracy of this program is less than that obtained by the Statistical Analysis System and the Statistical Package for Social Sciences. The data analysis output is only accurate to six digit places instead of ten digits.

```
 RU,AV33
RBF-P,Q,R   OR   AV33
       THREE WAY ANOVA WITH REPEATED MEASURES ON ALL FACTORS.
ENTER NAME OF DATA FILE
#JRBFR
 ENTER FORMAT OF DATA
(2(2X,F8.4))


 LEVELS OF A
2
 LEVELS OF B
2
 LEVELS OF C
2
 SS/CELL
4
ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
6
DO YOU WISH A PRINTOUT OF RAW DATA (1=YES, Ø=NO)
Ø
:
```

CELL	N	SUMX	SUMX2	MEAN	SD
1 1 1	4	15.000	63.000	3.750	1.500
1 1 2	4	16.000	66.000	4.000	.816
1 2 1	4	28.000	198.000	7.000	.816
1 2 2	4	32.000	258.000	8.000	.816
2 1 1	4	7.000	13.000	1.750	.500
2 1 2	4	12.000	38.000	3.000	.816
2 2 1	4	22.000	122.000	5.500	.577
2 2 2	4	40.000	402.000	10.000	.816

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	3.125	1	3.125	4.953	.035
B	162.000	1	162.000	256.755	.000
C	24.500	1	24.500	38.830	.000
AB	6.125	1	6.125	9.708	.005
AC	10.125	1	10.125	16.047	.000
BC	8.000	1	8.000	12.679	.000
ABC	3.125	1	3.125	4.953	.035
RESIDUAL	13.250	21.	.631		
TOTAL	235.500	31.			

111

```
0001    FTN4,L
0002           PROGRAM AV33
0003           DOUBLE PRECISION SJJ(10),CKK(10),SLL(50),PQQ(10),CK(10)
0004           DOUBLE PRECISION DXX(100)
0005           DOUBLE PRECISION CBB(10),ACC(10),BSS(100),CSS(100),CCC(600),
0006          $SSS(50),X,XS,SX,BX,SI,BA,CA,A,AS,AB,CB,AC,BC,SS,B,C,XN,XBAR,
0007          $SD,Z,O,O1,ZJ,ZI,ZM,ZZJ,ZZL,ZZM,XK,XKK,ZEE,P1,P2,ZZ,ZO,ZK1,ZK2
0008           DOUBLE PRECISION SX1(600),SX2(600),XR(20)
0009           DIMENSION NFILE(3),IFMT(20),IBUF(256),IB(272)
0010           INTEGER P,Q,R
0011           DATA SX/600*0.D0/,SX2/600*0.D0/
0012           DATA SJJ,SKK,SLL,PQQ,CK,DXX/190*0.D0/
0013           DATA CBB,ACC,BSS,CSS,SCC,SSS/870*0.D0/
0014           DATA XS,SX,BX,SI,BA,CA,A,AS,AB,AC,BC,SS,B,C/14*0.D0/
0015           WRITE(1,4400)
0016    4400   FORMAT ("R9F-P,Q,R   OR AV33 ",
0017          $/,5X,"THREE WAY ANOVA WITH REPEATED MEASURES ON ALL ",
0018          #" FACTORS.")
0019           WRITE(1,4401)
0020    4401   FORMAT("ENTER NAME OF DATA FILE")
0021           READ(1,7) NFILE
0022    7      FORMAT(3A2)
0023           WRITE(1,4402)
0024    4402   FORMAT ( " ENTER FORMAT OF DATA " )
0025           READ(1,6)IFMT
0026    6      FORMAT(20A2)
0027           CALL OPEN(IB,IER,NFILE,3,0,-2,256)
0028           IF(IER.LT.0) GO TO 999
0029           WRITE(1,4403)
0030    4403   FORMAT ( " LEVELS OF A " )
0031           READ(1,*)  P
0032           WRITE(1,4404)
0033    4404   FORMAT ( " LEVELS OF B " )
0034           READ(1,*)  Q
0035           WRITE(1,4405)
0036    4405   FORMAT ( " LEVELS OF C " )
0037           READ(1,*)  R
0038           WRITE(1,4406)
0039    4406   FORMAT ( " SS/CELL " )
0040           READ(1,*)  N
0041           O=Q*R*N
0042           WRITE(1,224)
0043    224    FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
0044           READ(1,*) IUNIT
0045           WRITE(1,223)
0046    223    FORMAT("DO YOU WISH A PRINTOUT OF RAW DATA (1=YES, 0=NO)")
0047           READ(1,*) IPTO
0048           DO 90 I=1,P
0049           DO 440 L=1,N
0050           DO 520 J=1,Q
0051           CALL READF(IB,IER,IBUF)
0052           CALL CODE
```

```
0053          READ(IBUF,IFMT) (XR(I3),I3=1,R)
0054          IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (XR(I2),I2=1,R)
0055          DO 695 K=1,R
0056          X=XR(K)
0057          III=(I-1)*Q*R + (J-1)*R +K
0058          SX2(III)=SX2(III) + X*X
0059          SX1(III)=SX1(III)+X
0060          XS=XS + X*X
0061          SX=SX + X
0062          BX=BX+X
0063          SI=SI+X
0064          SJJ(J)=SJJ(J)+X
0065          SKK(K)=SKK(K)+X
0066          SLL(L)=SLL(L)+X
0067          PQQ(J)=PQQ(J)+X
0068          CK(K)=CK(K)+X
0069          II=J+Q*(K-1)
0070          DXX(II)=DXX(II)+X
0071          CBB(II)=CBB(II)+X
0072          ACC(K)=ACC(K)+X
0073          II=J+Q*(L-1)
0074          BSS(II)=BSS(II)+X
0075          II=K+R*(L-1)
0076          CSS(II)=CSS(II)+X
0077          M=M+1
0078          SCC(M)=SCC(M)+X
0079    695   SSS(L)=SSS(L)+X
0080          BA=BA+BX*BX/R
0081    520   BX=0
0082          DO 440 K=1,R
0083          CA=CA+CK(K)*CK(K)/Q
0084    440   CK(K)=0
0085          A=A+SI*SI/(Q*R*N)
0086          SI=0
0087          DO 390 L=1,N
0088          AS=AS+SLL(L)*SLL(L)/(Q*R)
0089    390   SLL(L)=0
0090          DO 930 J=1,Q
0091          AB=AB+PQQ(J)*PQQ(J)/(R*N)
0092          PQQ(J)=0
0093          DO 930 K=1,R
0094          II=J+Q*(K-1)
0095          CB=CB+CBB(II)*CBB(II)/N
0096    930   CBB(II)=0
0097          DO 820 K=1,R
0098          AC=AC+ACC(K)*ACC(K)/(N*Q)
0099          ACC(K)=0
0100    820   M=0
0101    90    CONTINUE
0102          DO 1120 J=1,Q
0103          DO 1120 K=1,R
0104          II=J+Q*(K-1)
0105          BC=BC+DXX(II)*DXX(II)/(P*N)
0106    1120  CONTINUE
```

```
0107          DO 1040 L=1,N
0108          SS=SS+SSS(L)*SSS(L)/(P*Q*R)
0109   1040   CONTINUE
0110          DO 1240 J=1,Q
0111          B=B+SJJ(J)*SJJ(J)/(P*R*N)
0112   1240   CONTINUE
0113          DO 1250 K=1,R
0114          C=C+SKK(K)*SKK(K)/(P*Q*N)
0115   1250   CONTINUE
0116          X=SX*SX/(P*Q*R*N)
0117          WRITE(IUNIT,225)
0118   225    FORMAT(////,"0  CELL",5X,"N",11X,"SUMX",7X,"SUMX2",7X,"MEAN",
0119          17X,"SD",/)
0120          XN=N
0121          DO 226 I=1,P
0122          DO 226 J=1,Q
0123          DO 226 K=1,R
0124          III=(I-1)*Q*R +(J-1)*R +K
0125          XBAR=SX1(III)/XN
0126          SD=DSQRT((SX2(III)-(SX1(III)*SX1(III))/XN)/(XN-1.))
0127          WRITE(IUNIT,227) I,J,K,N,SX1(III),SX2(III),XBAR,SD
0128   227    FORMAT(3I2,3X,I4,3X,4(1X,F10.3))
0129   226    CONTINUE
0130          WRITE(IUNIT,2011)
0131   2011   FORMAT(1X,//,"                         SOURCE TABLE"
0132          ///,1X,"SOURCE          SS          DF          MS          F",
0133          112X,"P(F)",/)
0134          Z=XS+X-SS-CB
0135          O=(N-1)*(P*Q*R-1)
0136          O1=O
0137          ZJ=A-X
0138          K=P-1
0139          ZI=Z/O
0140          ZL=ZJ/K
0141          ZM=ZL/ZI
0142          ZZJ=B-X
0143          KK=Q-1
0144          ZZL=ZZJ/KK
0145          ZZM=ZZL/ZI
0146          XK=K
0147          XKK=KK
0148          CALL FPROB(ZM,XK,O1,ZEE,P1)
0149          CALL FPROB(ZZM,XKK,O1,ZEE,P2)
0150          WRITE(IUNIT,3110)ZJ,K,ZL,ZM,P1,ZZJ,KK,ZZL,ZZM,P2
0151   3110   FORMAT(1X," A          ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6,
0152          //"  B          ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6)
0153          ZJ=C-X
0154          K=R-1
0155          ZL=ZJ/K
0156          ZM=ZL/ZI
0157          ZZJ=AB+X-A-B
0158          KK=(P-1)*(Q-1)
0159          ZZL=ZZJ/KK
0160          ZZM=ZZL/ZI
```

```
0161          XK=K
0162          XKK=KK
0163          CALL FPROB(ZM,XK,01,ZEE,P1)
0164          CALL FPROB(ZZM,XKK,01,ZEE,P2)
0165          WRITE(IUNIT,2310)ZJ,K,ZL,ZM,P1,ZZJ,KK,ZZL,ZZM,P2
0166   2310   FORMAT(1X," C          ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6,
0167          //"   AB         ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6)
0168          ZJ=AC+X-A-C
0169          K=(P-1)*(R-1)
0170          ZL=ZJ/K
0171          ZM=ZI/ZI
0172          ZZJ=BC+X-B-C
0173          KK=(Q-1)*(R-1)
0174          ZZL=ZZJ/KK
0175          ZZM=ZZL/ZI
0176          ZK1=K
0177          ZK2=KK
0178          CALL FPROB(ZM,ZK1,01,ZEE,P1)
0179          CALL FPROB(ZZM,ZK2,01,ZEE,P2)
0180          WRITE(IUNIT,2510)ZJ,K,ZL,ZM,P1,ZZJ,KK,ZZL,ZZM,P2
0181   2510   FORMAT(1X," AC        ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6
0182          //"   BC        ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6)
0183          ZJ=CB+A+B+C-X-AB-AC-BC
0184          K=K*(P-1)
0185          ZL=ZJ/K
0186          ZM=ZL/ZI
0187          ZZ=XS-X
0188          ZO=N*P*Q*R-1
0189          XK=K
0190          CALL FPROB(ZM,XK,01,ZEE,P1)
0191          WRITE(IUNIT,2710)ZJ,K,ZL,ZM,P1,Z,O,ZI,ZZ,ZO
0192   2710   FORMAT(1X,"ABC        ",F8.3,5X,I3,2(5X,F8.3),3X,F10.6,
0193          //" RESIDUAL   ",F10.3,F8.0,5X,F8.3
0194          ///" TOTAL      ",F8.3,1X,F8.0,5X,F8.3,//)
0195          CALL CLOSE(IB,IER)
0196          GO TO 987
0197   999    WRITE(1,4408)
0198   4408   FORMAT (  "ERROR ON CALL OPEN STATEMENT"  )
0199   987    END
0200          END$
```

AC10   (CRAC)   (One-way Analysis of Covariance)

Purpose:

This program performs a one-way analysis of covariance for one covariate without replication.

Mathematical Model:

The model of this design is:

$$Y_{ij(adj)} = Y_{ij} - B'_w (X_{ij} - \overline{X}..) = u + B_j + C_{i(j}$$

where:

Y_{ij} = unadjusted criterion measure

B'_w = common population linerar regression coefficient for treatment levels

X_{ij} = covariate measure for subject i in treatment population j

The hypothesis to be tested is:

Ho: Bj = 0 for all j

The fixed effect model (Model I) was assumed in the deviation of the expected values of the mean squares.

Layout of Design:

b_1		b_2		b_k	
Y	X	Y	X	Y	X
S_1		S_2		S_j	

1. There are k levels of treatment B.

2. Subjects are randomly assigned with each subject designated to receive only one level.

3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

4. The relationship of the dependent variable and the covariate must be linear.

User Considerations and Procedures:

1. A data file must be created in sequential form. For each subject, enter the dependent measure (Y) first, then the covariate (X). (For example, subject one for treatment b_1, and the covariate is the first record, subject two for treatment b_1, and the covariate is the second record. Repeat for all subjects in b_1 then index to the next level of B.) A printout of raw data should show two data points per line.

2. The data analysis can either be displayed on the CRT or a hardcopy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of B (maximum 100)

   b. number of subjects per group (level) (maximum 32767)

   c. name of data file

   d. format of data file

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σy, Σy^2, $\overline{Y}$, SD

   c. ANOVA source table

   d. intermediate calculations of the adjusted scores

   e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of covariance, the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp.465-472.

Test Data:

This program was tested using data from Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 465-467. This program uses double precision in all calculations.

```
  RU,AC1Ø
CRAC-K OR AC1Ø ANALYSIS OF COVARIANCE
    NOTE:   PROGRAM EXPECTS DATA IN ONE SEQUENTIAL FILE
            INDEXING FOR SUBJECTS, FIRST THEN, GROUPS -
            WITH TWO POINTS PER LINE DEPENDENT VARIABLE THEN COVARIATE
 ENTER NAME OF YOUR FILE FROM DATA3Ø PROGRAM
 #JACOV
 ENTER THE RECORD LENGTH AS IN DA3Ø
28
 ENTER FORMAT OF DATA
(2(4X,F1Ø.4))
 HOW MANY GROUPS?
4
 HOW MANY SUBJECTS/GROUPS?
8
 ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER Ø
1
 ENTER 1 FOR CRT DISPLAY, OR 6 FOR LINEPRINTER
6
  AC1Ø  :  STOP  ØØØØ
 :
```

3.0000	42.0000
6.0000	57.0000
3.0000	33.0000
3.0000	47.0000
1.0000	32.0000
2.0000	35.0000
2.0000	33.0000
2.0000	39.0000
4.0000	47.0000
5.0000	49.0000
4.0000	42.0000
3.0000	41.0000
2.0000	38.0000
3.0000	43.0000
4.0000	48.0000
3.0000	45.0000
7.0000	61.0000
3.0000	65.0000
7.0000	64.0000
6.0000	56.0000
5.0000	52.0000
6.0000	58.0000
5.0000	53.0000
6.0000	54.0000
7.0000	65.0000
8.0000	74.0000
9.0000	80.0000
8.0000	73.0000
10.0000	85.0000
10.0000	82.0000
9.0000	78.0000
11.0000	89.0000

Y-TERMS (DEP. VAR.)
(BS)	1160.000
(Y)	924.500
(B)	1119.000

X-TERMS (COVAR.)
(BS)	105202.000
(X)	96800.000
(B)	103997.250

XY-TERMS
(BS)	10840.000
(XY)	9460.000
(B)	10637.750

CELL	N	SUMX	SUMX2	MEAN	SD
1	8	22.000	76.000	2.750	1.488
2	8	28.000	1 9.000	3.500	.926
3	8	50.000	320.000	6.250	1.035
4	8	72.000	660.000	9.000	1.309

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
TOTAL	8.840	30.			
BETWEEN GRPS	1 793	3.00	.598	2.290	.100
WITHIN GRPS	7.047	27.	.261		

CORRELATION COEFFICIENTS

BETWEEN GRPS	.995
WITHIN GRPS	.910
TOTAL	.981

```
0001   FTN4
0002          PROGRAM AC10
0003          DIMENSION NFILE(3),IFMT(20)
0004          DOUBLE PRECISION X,Y,SX,SY,YS,XS,GX,GY,XB,YB,GG,X2,SS,C,D,ZI
0005          DOUBLE PRECISION ZJ,ZN,ZNJ,BN,BNK1,BN2,QN,XN,Y2,XY
0006          DIMENSION IB(272),IBUF(256)
0007          DOUBLE PRECISION SUMX(100),SUMX2(100)
0008          SX=0.
0009          SY=0.
0010          XY=0.
0011          YS=0.
0012          XS=0.
0013          GX=0.
0014          XB=0.
0015          YB=0.
0016          GG=0.
0017          WRITE(1,4400)
0018   4400   FORMAT ( "CRAC-K  OR AC10  ANALYSIS OF COVARIANCE " ,
0019          $/,5X,"NOTE: PROGRAM EXPECTS DATA IN ONE SEQUENTIAL FILE",
0020          %/,11X,"INDEXING FOR SUBJECTS , FIRST THEN, GROUPS -  ",/,
0021          &11X,"WITH TWO POINTS PER LINE   DEPENDENT  VARIABLE THEN ",
0022          #"COVARIATE.  ",11X," MAX 100 GROUPS")
0023          WRITE(1,4401)
0024   4401   FORMAT ( "ENTER NAME OF YOUR FILE FROM DATA30 PROGRAM"  )
0025          READ(1,99)NFILE
0026   99     FORMAT(3A2)
0027          IDCBS=256
0028          CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
0029          IF(IER.GE.0) GO TO 689
0030          WRITE(1,345) NFILE,IER
0031   345    FORMAT(5X,3A2," FAILED TO OPEN , IER = ",I5)
0032          STOP 345
0033   689    WRITE(1,4402)
0034   4402   FORMAT ( "ENTER FORMAT OF DATA" )
0035          READ(1,6)IFMT
0036   6      FORMAT(20A2)
0037          WRITE(1,4403)
0038   4403   FORMAT ( " HOW MANY GROUPS?  ")
0039          READ(1,*) K
0040          WRITE(1,4404)
0041   4404   FORMAT ( " HOW MANY SUBJECTS/GROUP?  ")
0042          READ(1,*) N
0043          BN=N*K
0044          XN=N
0045          WRITE(1,9001)
0046   9001   FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
0047          READ(1,*) IPTO
0048          WRITE(1,1234)
0049   1234   FORMAT("ENTER 1 FOR CRT DISPLAY, OR 6 FOR LINEPRINTER")
0050          READ(1,*) IUNIT
0051          DO230 I=1,K
```

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```
0052         IF(IPTO.EQ.1) WRITE(IUNIT,903)
0053   903   FORMAT(//)
0054         DO330 J=1,N
0055         CALL READF(IB,IER,IBUF)
0056         CALL CODE
0057         READ(IBUF,IFMT)Y,X
0058         IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
0059         SX=SX+X
0060         SUMX(I)=SUMX(I)+Y
0061         SUMX2(I)=SUMX2(I)+Y*Y
0062         SY=SY+Y
0063         XY=XY+X*Y
0064         YS=YS+Y*Y
0065         XS=XS+X*X
0066         GX=GX+X
0067   330   GY=GY+Y
0068   3109  FORMAT(//)
0069         XB=XB+GX*GX/XN
0070         YB=YB+GY*GY/XN
0071         GG=GG+GX*GY/XN
0072         Y=GY/XN
0073         X=GX/XN
0074         GX=0
0075         GY=0
0076   230   CONTINUE
0077         Y2=SY*SY/BN
0078         X2=SX*SX/BN
0079         SS=SY*SX/BN
0080         WRITE(IUNIT,600)
0081   600   FORMAT(1X,//)
0082         WRITE(IUNIT,161)YS,Y2
0083   161   FORMAT(1X,"Y-TERMS(DEP. VAR.) ",/," (BS) ",F12.3,/,1X,"(Y)",2X,
0084        $F12.3)
0085         WRITE(IUNIT,171)YB
0086   171   FORMAT(" (B)",2X,F12.3,//,1X,"X-TERMS(COVAR.)")
0087         WRITE(IUNIT,1711)XS,X2
0088   1711  FORMAT(1X,"(BS)",1X,F12.3,/,1X,"(X)",2X,F12.3)
0089         WRITE(IUNIT,181)XB,XY,SS,GG
0090   181   FORMAT(" (B)",2X,F12.3,//,1X,"XY-TERMS",/,1X,"(BS)",1X,F12.3,/,
0091        X1X,"(XY)",1X,F12.3,/,1X,"(B) ",1X,F12.3)
0092         WRITE(IUNIT,453)
0093   453   FORMAT(////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
0094        110X,"SD",/)
0095         DO228 I=1,K
0096         XB1=SUMX(I)/XN
0097         SD1=DSQRT((SUMX2(I)-(SUMX(I)*SUMX(I))/XN)/(XN-1))
0098         WRITE(IUNIT,229) I,N,SUMX(I),SUMX2(I),XB1,SD1
0099   229   FORMAT(1X,I3,3X,I3,4(3X,F10.3))
0100   228   CONTINUE
0101         C=YS-Y2-(XY-SS)*(XY-SS)/(XS-X2)
0102         D=YS-YB-(XY-GG)*(XY-GG)/(XS-XB)
0103         ZI=C-D
0104         ZJ=D/(BN-K-1)
0105         ZN=ZI/(K-1)
0106         WRITE(IUNIT,531)
```

```
0107   531    FORMAT(1X,//,17X,"SOURCE TABLE")
0108          WRITE(IUNIT,536)
0109   536    FORMAT(1X,/,4X,"SOURCE",11X,"SS",8X,"DF",9X,"MS",9X,"F",9X,
0110         1"P(F)")
0111          K1=K-1
0112          ZNJ=ZN/ZJ
0113          BNK1=BN-K-1
0114          BN2=BN-2
0115          WRITE(IUNIT,700)C,BN2
0116   700    FORMAT(1X,"TOTAL",7X,F12.3,5X,F4.0)
0117          DF1=K1
0118          DF2=BNK1
0119          F=ZNJ
0120          CALL FPROB(F,DF1,DF2,Z3,PF1)
0121          WRITE(IUNIT,541)ZI,K1,ZN,ZNJ,PF1
0122   541    FORMAT(/,1X,"BETWEEN GRPS",F12.3,4X,F4.3,3(5X,F7.3),/)
0123          WRITE(IUNIT,551)D,BNK1,ZJ
0124   551    FORMAT(1X,"WITHIN GRPS",1X,F12.3,5X,F4.0,4X,F7.3)
0125          C=(XY-SS)/DSQRT((XS-X2)*(YS-Y2))
0126          D=(GG-SS)/DSQRT((XB-X2)*(YB-Y2))
0127          QH=(XY-GG)/DSQRT((XS-XB)*(YS-YB))
0128          WRITE(IUNIT,571)
0129   571    FORMAT(1X,//," CORRELATION COEFFICIENTS ")
0130          WRITE(IUNIT,581)D,QH
0131   581    FORMAT(2X,/,1X,"BETWEEN GRPS",F9.3,/,1X,"WITHIN GRPS",1X,F9.3)
0132          WRITE(IUNIT,5811)C
0133   5811   FORMAT(4X,"TOTAL   ",2X,F9.3,/)
0134          CALL CLOSE(IB,IER)
0135          STOP
0136          END
0137          END$
```

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AC11   (RBAC-K)   (One-way Analysis of Covariance, Repeated Measures)

Purpose:

   This program performs a one-way analysis of covariance for one
   covariate with replication either by using matched subjects or
   repeated measures.

Mathematical Model:

   The model for this design is:

   $$Y_{ij(adj)} = Y_{ij} - B'_w(X_{ij} - \bar{X}..) = u + B_j + \tau_i + E_{ij}$$

   where:

   Y_{ij} = readjusted criterion measure

   B'_w = common populaton 'inear regression coefficient for
        treatment levels

   The hypothesis to be tested is:

   Ho: B_j = 0 for all j

   The fixed effect model (Model I) was assumed in the derivation of
   the expected values of the mean squares.

Layout of Design:

b_1		b_2		b_k	
Y	X	Y	X	Y	X
S_1		S_1		S_1	

S represents a
set of subjects

1. There are k levels of treatment B.

2. Subjects are assigned to a treatment so that the variability
    within a treatment is less than the variability among treat-
    ments. Homogeneity within treatments may be achieved by
    using a subject as his own control or match subjects on the
    basis of a variable that correlates with the dependent variable.

3. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

4. The relationship of the dependent variable and the covariate is linear.

5. For repeated measures, the dependent measure for each subject is paired with a unique covariate measure. The covariate cannot be identical for all measures, e.g., age of a subject.

User Considerations and Procedures:

1. A data file must be created in sequential form, with the dependent measure (Y) first, then the covariate (X). (For example, subject one for treatment b_1 and the covariate is the first record, subject two for treatment b_1 and the covariate is the second record. Follow this procedure for all subjects in b_1 then index to the next level of B.) A printout of raw data shows two data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of B (maximum 100)

   b. number of subjects per group (level) (maximum 32767)

   c. name of data file

   d. format of data file

   e. correlation coefficients

5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σy, Σy^2, $\overline{Y}$, SD

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c. ANOVA source table

d. intermediate calculations of the adjusted scores

e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependnet variable. With analysis of covariance, the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavorial Sciences, Wadsworth Publishing Company, 1968. Pp. 475-477.

Test Data:

This program was tested by comparing the results of the AC11 program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

```
RU,AC11
AC11 OR
RBAC-K    ONE-WAY ANALYSIS OF COVARIANCE FOR
          REPEATED MEASURES.  DATA INPUT READ SEQUENCE
          INDEX FOR SUBJECTS, THEN FOR WITHIN FACTOR.  ENTER THE
          DEPENDENT VARIABLE, THEN THE COVARIATE
ENTER NAME OF THE DATA FILE
#JRBAC
 ENTER FORMAT OF DATA
(2(2X,F8.4))
 HOW MANY TREATMENTS?
4
 HOW MANY SUBJECTS?
6
 ENTER THE RECORD LENGTH AS IN DA30
20
ENTER 1 FOR RAW DATA PRINTOUT (1=YES)
1
ENTER 1 FOR CRT PRINTOUT, 6 FOR LPTR
6
  AC11 : STOP    0000
:
```

202.0000	28.0000		
145.0000	23.0000		
188.0000	27.0000		
201.0000	24.0000		
202.0000	30.0000		
228.0000	30.0000		
MEAN-Y	194.333	MEAN-X	27.000
165.0000	22.0000		
201.0000	26.0000		
185.0000	24.0000		
231.0000	28.0000		
178.0000	26.0000		
221.0000	25.0000		
MEAN-Y	196.833	MEAN-X	25.167
191.0000	27.0000		
203.0000	28.0000		
185.0000	27.0000		
238.0000	30.0000		
198.0000	26.0000		
207.0000	27.0000		
MEAN-Y	203.667	MEAN-X	27 500
134.0000	19.0000		
180.0000	24.0000		
220.0000	28.0000		
261.0000	30.0000		
226.0000	29.0000		
204.0000	24.0000		
MEAN-Y	204.167	MEAN-X	25.667

```
Y-TERMS (DEP. VAR.)
(BS)        976280.000
(Y)         957601.500
(B)         958037.667
(S)         967091.500

X-TERMS (COVAR.)
(BS)        16824.000
(:')        16642.667
(B)         16664.333
(S)         16688.500

Y-TERMS
(BS)        127727.000
(XY)        126242.000
(B)         126250.500
(S)         126801.250
```

CELL	N	SUMX	SUMX2	MEAN	SD
1	6	1166.000	230362.000	194.333	27.457
2	6	1181.000	235737.000	196.833	25.600
3	6	1222.000	250612.000	203.667	18.608
4	6	1225.000	259569.000	204.167	43.508

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
TREATMENT	1502.394	3.	500.798	5.150	.0132
BLOCKS	3227.275	5.	645.455	6.638	.0026
RESIDUAL	1361.286	14.	97.235		
TOTAL	6517.333	22.			

CORRELATION COEFFEC ENTS

TREATMENTS	.087
BLOCKS	.848
RESIDUAL	.919
TOTAL	.807

```
0001   FTN4
0002        PROGRAM AC11
0003        REAL X1,K1X1
0004        DOUBLE PRECISION S1A,S2A,X,Y,SX,SY,YS,XS,GX,X2,GY
0005        DOUBLE PRECISION XB,YB,GG,ZK,S1,S2,SS,Y2,C,ZJ,ZI,D,ZI1,ZN
0006        DOUBLE PRECISION GXB,XB,SD,X1,X3,XN
0007        DOUBLE PRECISION S1A(100),S2A(100),X1(100),X3(100)
0008        DIMENSION NFILE(3),IFMT(20),IB(272),IBUF(256)
0009        WRITE(1,4399)
0010   4399 FORMAT(" AC11 OR ",/,
0011      C" RBAC-K    ONE-WAY ANALYSIS OF COVARIANCE FOR ",/,
0012      $"          REPEATED MEASURES.  DATA INPUT READ SEQUENCE",/,
0013      %10X,"INDEX FOR SUBJECTS, THEN FOR WITHIN FACTOR. ENTER THE",/,
0014      &10X,"DEPENDENT VARIABLE, THEN THE COVARIATE")
0015        WRITE(1,987)
0016   987  FORMAT("ENTER NAME OF THE DATA FILE")
0017        READ(1,16)NFILE
0018   16   FORMAT(3A2)
0019        WRITE(1,4401)
0020   4401 FORMAT ( " ENTER FORMAT OF DATA " )
0021        READ(1,6)IFMT
0022   6    FORMAT(20A2)
0023        WRITE(1,4402)
0024   4402 FORMAT ( " HOW MANY TREATMENTS?  ")
0025        READ(1,*) K
0026        WRITE(1,4403)
0027   4403 FORMAT ( " HOW MANY SUBJECTS?  ")
0028        READ(1,*) N
0029        IDCBS=256
0030        CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
0031        IF (IER.LT.0) GO TO 999
0032        WRITE(1,154)
0033   154  FORMAT("ENTER 1 FOR RAW DATA PRINTOUT(1=YES)")
0034        READ(1,*) IPTO
0035        WRITE(1,912)
0036   912  FORMAT("ENTER 1 FOR CRT PRINTOUT, 6 FOR LPTR")
0037        READ(1,*) IUNIT
0038        BN=N*K
0039        XN=N
0040        DO 230 I=1,K
0041        DO 330 J=1,N
0042        CALL READF(IB,IER,IBUF)
0043        CALL CODE
0044        READ(IBUF,IFMT) Y,X
0045        IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
0046        SX=SX+X
0047        X1(I)=X1(I)+Y
0048        X3(I)=X3(I)+Y*Y
0049        SY=SY+Y
```

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```
0050        XY=XY+X*Y
0051        YS=YS+Y*Y
0052        XS=XS+X*X
0053        GX=GX+X
0054        GY=GY+Y
0055        S1A(J)=S1A(J)+Y
0056   330  S2A(J)=S2A(J)+X
0057        XB=XB+GX*GX/XN
0058        YB=YB+GY*GY/XN
0059        GG=GG+GX*GY/N
0060        GY=GY/N
0061        GX=GX/N
0062        WRITE(IUNIT,231)GY,GX
0063   231  FORMAT(1X," MEAN-Y ",F10.3,4X," MEAN-X ",F10.3)
0064        GX=0
0065        GY=0
0066   230  CONTINUE
0067        DO 190 J=1,N
0068        ZK=K
0069        S1=S1+S1A(J)*S1A(J)/ZK
0070        S2=S2+S2A(J)*S2A(J)/ZK
0071   190  S3=S3+S1A(J)*S2A(J)/ZK
0072        Y2=SY*SY/BN
0073        X2=SX*SX/BN
0074        SS=SY*SX/BN
0075        WRITE(IUNIT,600)
0076   600  FORMAT(1X,//)
0077        WRITE(IUNIT,161)YS,Y2
0078   161  FORMAT(1X,"Y-TERMS(DEP. VAR.) ",/," (BS) ",F12.3,/,1X,"(Y)",2X,
0079       1F12.3)
0080        WRITE(IUNIT,171)YB,S1
0081   171  FORMAT(" (B)",2X,F12.3,/," (S)",2X,F12.3,//,1X,
0082       C"X-TERMS(COVAR.)")
0083        WRITE(IUNIT,1711)XS,X2
0084   1711 FORMAT(1X,"(BS)",1X,F12.3,/,1X,"(X)",2X,F12.3)
0085        WRITE(IUNIT,181)XB,S2,XY,SS,GG
0086   181  FORMAT(" (B)",2X,F12.3,/," (S)",2X,F12.3,//,"XY-TERMS",/,
0087       X" (BS)",1X,   F12.3,/,1X,"(XY)",1X,F12.3,/,1X,"(B) ",1X,F12.3)
0088        WRITE(IUNIT,1811)S3
0089   1911 FORMAT(" (S)",2X,F12.3)
0090        C=YS-Y2-(XY-SS)*(XY-SS)/(XS-X2)
0091        ZJ=YS+Y2-YB-S1
0092        X=XS+X2-XB-S2
0093        ZI=XY+SS-GG-S3
0094        D=ZJ-ZI*ZI/X
0095        Y=S1-Y2+ZJ-(S3-SS+ZI)*(S3-SS+ZI)/(S2-X2+X)-D
0096        ZI1=YB-Y2+ZJ-(GG-SS+ZI)*(GG-SS+ZI)/(XB-X2+X)-D
0097        X=N-1
0098        GY=Y/X
0099        ZJ=D/((K-1)*X-1)
0100        ZN=ZI1/(K-1)
0101        WRITE(IUNIT,703)
0102   703  FORMAT(////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",6X,"MEAN",
0103       111X,"SD",/)
```

```
0104          XN=N
0105          GXB=XB
0106          DO 704 I=1,K
0107          XB=X1(I)/XN
0108          SD=DSQRT((X3(I)-(X1(I)*X1(I))/XN)/(XN-1.))
0109    704   WRITE(IUNIT,709) I,N,X1(I),X3(I),XB,SD
0110    709   FORMAT(2I5,1X,4(3X,F10.3))
0111          WRITE(IUNIT,531)
0112    531   FORMAT(1X,//,17X,"SOURCE TABLE")
0113          GX=GY/ZJ
0114          XB=GXB
0115          K1=K-1
0116          K1X1=(K-1)*X-1.
0117          ZNJ=ZN/ZJ
0118          CALL FPROB(ZNJ,K1,K1X1,ZT1,PF1)
0119          DF1=X
0120          GX1=GX
0121          CALL FPROB(GX1,DF1,K1X1,ZT2,PF2)
0122          WRITE(IUNIT,536)
0123    536   FORMAT(1X,/,4X,"SOURCE",11X,"SS",8X,"DF",9X,"MS",9X,"F",
0124          18X,"P(F)",//)
0125          WRITE(IUNIT,541)ZI1,K1,ZN,ZNJ,PF1
0126    541   FORMAT(1X,"TREATMENT    ",3X,F9.3,F7.0,6X,F7.3,3X,F7.3,3X,F7.4)
0127          WRITE(IUNIT,542)Y,X,GY,GX,PF2
0128    542   FORMAT(1X,"BLOCKS       ",2X,F9.3,1X,F7.0,5X,F7.3,3X,F7.3,
0129          13X,F7.4)
0130    C     RESIDUAL
0131          K1X1=(K-1)*X-1
0132          WRITE(IUNIT,545)D,K1X1,ZJ
0133    545   FORMAT(1X,"RESIDUAL     ",2X,F9.3,F7.0,4X,F9.3)
0134          BN2=BN-2
0135          WRITE(IUNIT,551)C,BN2
0136    551   FORMAT(1X,"TOTAL",8X,F12.3,4X,F7.0)
0137          X=(S3-SS)/DSQRT((S1-Y2)*(S2-X2))
0138          C=(XY-SS)/DSQRT((XS-X2)*(YS-Y2))
0139          D=(GG-SS)/DSQRT((XB-X2)*(YB-Y2))
0140          ZN=(XY+SS-GG-S3)/DSQRT((YS+Y2-YB-S1)*(XS+X2-XB-S2))
0141          WRITE(IUNIT,581)D
0142    581   FORMAT(1X,//,1X,"CORRELATION COEFFECIENTS",//," TREATMENTS",2X,
0143          1F5.3)
0144          WRITE(IUNIT,582)X,ZN,C
0145    582   FORMAT(" BLOCKS",6X,F5.3,//," RESIDUAL  ",2X,F5.3,//," TOTAL    ",
0146          24X,F5.3)
0147          CALL CLOSE(IB,IER)
0148          STOP
0149    999   WRITE(1,4408)
0150    4408  FORMAT ( " ERROR ON CALL OPEN STATEMENT "  )
0151          STOP
0152          END
0153          END$
```

AC20   (CRFAC-P,Q)   (Two-way Analysis of Covariance)

Purpose:

   This program performs a two-way analysis of covariance for one
   covariate without replication.

Mathematical Model:

   The model of this design is:

$$Y_{ijm(adj)} = Y_{ijm} - B'_w + (X_{ijm} - \overline{X}...) = u + A_i + B_j + AB_{ij} + E_{m(ij)}$$

   where:

   Y_{ij} = unadjusted criterion measure

   B'_w = common population linear regression coefficient for treatment
       levels

   X_{ij} = covariate measure for subject i in treatment population j

   The hypotheses to be tested are:

   Ho: A_i = 0 for all i
   Ho: B_j = 0 for all j
   Ho: AB_{ij} = 0 for all ij

   The fixed effect model (Model I) was assumed in the derivation of the
   expected values of the mean squares.

Layout of Design:

A_1		A_2		A_3	
B_1	B_2	B_1	B_2	B_1	B_2
X Y	X Y	X Y	X Y	X Y	X Y
S_1	S_2	S_3	S_4	S_5	S_6

S represents a
set of subjects

1. There are two Factors (A,B) with p and q levels of treatments,
    respectively. The experiment consists of pq treatment combin-
    ations. The above example includes three levels of Factor A,
    two levels of Factor B.

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2. Subjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination.

3. There should be more than one subject per pq treatment combination.

4. The experiment contains a source of variation believed to affect the dependent variable and is considered irrelevant to the objectives of the experiment. A measure of the extraneous variation can be obtained which does not include effects attributable to the treatment.

5. The relationship of the dependent variable and the covariate is linear.

User Considerations and Procedures:

1. A data file must be created in sequential form with the dependent variable (Y) first, then the covariate (X). On read, indexing for subjects comes first, then for Factor B, and finally Factor A. (For example, first record is subject one for treatment and covariate of ab_{11}, second record is subject two for treatment and covariate of ab_{11}; continue for all subjects in treatment ab_{11}. Next, enter all subjects for treatment ab_{12}; repeat for ab_{1q}. Then enter data for ab_{21} . . ., the final record would be subject n for treatment ab_{pq}.) A printout of the raw data would show two data points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of levels of Factor A (see comments)

   b. number of levels of Factor B (see comments)

   c. number of subjects per AB cell (maximum 32767) (see comments)

   d. name of the data file

   e. format of data file

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5. Printout gives:

   a. raw data by group (optional)

   b. for each group: N, Σy, Σy^2, $\overline{Y}$, SD

   c. ANOVA source table

   d. intermediate calculations of the adjusted scores

   e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental
error and obtain unbiased estimates of treatment effects. The procedure
involves measuring the dependent variable and an additional covariate.
The covariate represents a source of variation that has not been con-
trolled in the experiment and is believed to affect the dependent
variable. With analysis of the covariance the dependent measure can
be adjusted so as to remove the effects of the uncontrolled source
of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted
for the covariate. The intermediate calculations given on the print-
out of the data must be used to adjust the means. Computation pro-
cedures and notation references can be found in Roger E. Kirk,
Experimental Design Procedures for the Behavioral Sciences. Wadsworth
Publishing Company, 1968, Pp. 479-482.

This program has the following restrictions:

1. The number of subjects per AB treatment combinations should be
   equal.

2. There cannot be more than 400 treatment combinations ($p*q \leqslant 400$).

Test Data:

This program was tested by comparing the results of the AC20 program
to results obtained from a similar PDP 8/e Analysis of Covariance
program. The program uses double precision in all calculations.

```
   RU,AC2Ø
AC2Ø OR
CRFAC-P,Q    ANALYSIS OF COVARIANCE ON TWO FACTORS
             WITH NO REPEATED MEASURES.  ON INPUT READ SEQUENCE, INDEX
             FOR SUBJECTS FIRST, THEN FACTOR B AND FINALLY FACTOR A.
             PROGRAM EXPECTS 2 DATA POINTS PER LINE - DEPENDENT VARIABLE,
             THEN THE COVARIATE
ENTER DATA FILE NAME
#JCRFA
ENTER FORMAT OF DATA FILE
(2(2X,F8.4))
 ENTER THE RECORD LENGTH AS IN DA3Ø
2Ø
 HOW MANY LEVELS OF A?
2
 HOW MANY LEVELS OF B?
3
 HOW MANY LEVELS OF SS/CELL?
5
ENTER 1 FOR PRINTOUT OF RAW DATA, Ø IF NOT
1
ENTER 1 FOR CRT PRINTOUT, OR 6 FOR LPTR
6
  AC2Ø  :  STOP     ØØØØ
:
```

Y	X
95.0000	40.0000
80.0000	35.0000
95.0000	40.0000
105.0000	50.0000
100.0000	45.0000
85.0000	30.0000
100.0000	40.0000
85.0000	45.0000
90.0000	40.0000
90.0000	40.0000
90.0000	50.0000
85.0000	40.0000
90.0000	40.0000
80.0000	30.0000
85.0000	40.0000
100.0000	50.0000
95.0000	30.0000
95.0000	35.0000
110.0000	45.0000
88.0000	30.0000
100.0000	50.0000
90.0000	30.0000
95.0000	40.0000
90.0000	45.0000
95.0000	40.0000
95.0000	45.0000
85.0000	30.0000
75.0000	25.0000
105.0000	50.0000
85.0000	35.0000

Y-TERMS (DEPENDENT VARIABLE)

(A)	253628.9333	(B)	253939.4000	(AB)	254018.8000
(ABS)	255444.0000	(Y)	253552.1333		

X-TERMS (COVARIABLE)

(A)	46828.3333	(B)	46822.5000	(AB)	46895.0000
(ABS)	48325.0000	(X)	46807.5000		

XY-TERMS
(A)   108901.0000   (B)   109007.5000   (AB)   108979.0000
(ABS) 110065.0000   (XY) 108941.0000

CELL	N	SUMX	SUMX2	MEAN	SD
1 1	5	475.000	45475.000	95.000	9.354
1 2	5	450.000	40650.000	90.000	6.124
1 3	5	430.000	37050.000	86.000	4.183
2 1	5	488.000	47894.000	97.600	8.142
2 2	5	470.000	44250.000	94.000	4.183
2 3	5	445.000	40125.000	89.000	11.402

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	147.423	1	147.423	5.64701	.02477
B	292.811	2	146.405	5.60802	.01036
AB	14.412	2	7.206	.27603	.76459
ERROR	600.448	23	26.106		
TOTAL	1059.329	28			

CORRELATION COEFFICIENTS

A	-1.000
B	.873
AB	.992
ERROR	.761
TOTAL	.663

```
0001  FTN4
0002         PROGRAM AC20
0003         INTEGER P,Q,D
0004         DOUBLE PRECISION BXX(400),X,Y,SX,SY,ZS,YX,XS,SA,AS,SH,SNS,BA,XN
0005         DOUBLE PRECISION AB,ZZ,SNSN,SHH,AX,AY,AZ,ASQN,SAQN,PQN,SZ,BY,
0006        1BX,BZ,BYJPN,BXJPN,C,DD,ZI,ZZ,AYSX,BYSX,BASX,BYY(400)
0007         DOUBLE PRECISION PQN,QN,PN
0008         DIMENSION IB(272),IBUF(256),NFILE(3),IFMT(20)
0009         DOUBLE PRECISION SUMX(400),SUMX2(400)
0010         DO 897 K=1,400
0011         BXX(K)=0.
0012  897    BYY(K)=0.
0013         WRITE(1,3999)
0014  3999   FORMAT("AC20 OR ",/,
0015        C"CRFAC-P,Q   ANALYSIS OF COVARIANCE ON TWO FACTORS",/,
0016        #13X,"WITH NO REPEATED MEASURES. ON INPUT READ SEQUENCE, INDEX",
0017        %/13X,"FOR SUBJECTS FIRST, THEN FACTOR B AND FINALLY FACTOR A.",
0018        &/,13X,"PROGRAM EXPECTS 2 DATA POINTS PER LINE - DEPENDENT "
0019        B,"VARIABLE",/,13X,", THEN THE COVARIATE",/,
0020        C"ENTER DATA FILE NAME")
0021         READ(1,568) NFILE
0022  568    FORMAT(3A2)
0023         WRITE(1,1456)
0024  1456   FORMAT("ENTER FORMAT OF DATA FILE")
0025         READ(1,435) IFMT
0026         IDCBS=256
0027  435    FORMAT(20A2)
0028         CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
0029         IF(IER.GE.0) GO TO 123
0030         WRITE(1,543) NFILE,IER
0031  543    FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
0032         STOP 543
0033  123    WRITE(1,4401)
0034  4401   FORMAT ( " HOW MANY LEVELS OF A? ")
0035         READ(1,*)  P
0036         WRITE(1,4402)
0037  4402   FORMAT ( " HOW MANY LEVELS OF B? ")
0038         READ(1,*)  Q
0039         WRITE(1,4403)
0040  4403   FORMAT ( " HOW MANY LEVELS OF SS/CELL? ")
0041         READ(1,*)  N
0042         WRITE(1,757)
0043  757    FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA , 0 IF NOT")
0044         READ(1,*) IPTO
0045         WRITE(1,987)
0046  987    FORMAT("ENTER 1 FOR CRT PRINTOUT, OR 6 FOR LPTR")
0047         READ(1,*) IUNIT
0048         IF(IPTO.EQ.1) WRITE(IUNIT,109)
0049  109    FORMAT(//,5X,"Y",10X,"X",//)
0050         XN=N
```

```
0051          DO 240 I=1,P
0052          DO 330 J=1,Q
0053          DO 440 K=1,N
0054          CALL READF(IB,IER,IBUF)
0055          CALL CODE
0056          READ(IBUF,IFMT) Y,X
0057          IF (IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
0058          SX=SX+X
0059          JJ=(I-1)*Q+J
0060          SUMX(JJ)=SUMX(JJ)+Y
0061          SUMX2(JJ)=SUMX2(JJ)+Y*Y
0062          SY=SY+Y
0063          ZS=ZS+X*Y
0064          YS=YS+Y*Y
0065          XS=XS+X*X
0066          SA=SA+X
0067          AS=AS+Y
0068          SN=SN+X
0069          SNS=SNS+Y
0070          BXX(J)=BXX(J)+X
0071     440  BYY(J)=BYY(J)+Y
0072          IF (IPTO.EQ.1) WRITE(IUNIT,33)
0073     33   FORMAT(//)
0074          BA=BA+SNS*SNS/XN
0075          AB=AB+SN*SN/XN
0076          ZZ=ZZ+SNS*SN/XN
0077          SNSN=SNS/XN
0078          SNN=SN/XN
0079          SN=0
0080     330  SNS=0
0081          QN=Q*N
0082          AX=AX+SA*SA/QN
0083          AY=AY+AS*AS/QN
0084          AZ=AZ+SA*AS/QN
0085          ASQN=AS/QN
0086          SAQN=SA/QN
0087          SA=0
0088     240  AS=0
0089          PQN=P*Q*N
0090          SZ=SY*SX/PQN
0091          SY=SY*SY/PQN
0092          SX=SX*SX/PQN
0093          DO 620 J=1,Q
0094          PN=P*N
0095          BY=BY+BYY(J)*BYY(J)/PN
0096          BX=BX+BXX(J)*BXX(J)/PN
0097          BZ=BZ+BXX(J)*BYY(J)/PN
0098          BYJPN=BYY(J)/PN
0099          BXJPN=BXX(J)/PN
0100     620  CONTINUE
0101          WRITE(IUNIT,171)AY,BY,BA,YS,SY
0102     171  FORMAT(//,1X,"Y-TERMS (DEPENDENT VARIABLE)",
0103          X/," (A)   ",F13.4,5X,"  (B)",F13.4,5X,"  (AB)",F13.4,
0104          X/," (ABS)",F13.4,5X,"  (Y)",F13.4,/)
```

```
0105          WRITE(IUNIT,177)AX,BX,AB,XS,SX
0106   177    FORMAT(1X,"X-TERMS (COVARIABLE)",
0107          X/," (A)  ",F13.4,5X,"  (B)",F13.4,5X,"  (AB)",F13.4,
0108          X/," (ABS)",F13.4,5X,"  (X)",F13.4,/)
0109          WRITE(IUNIT,183)AZ,BZ,ZZ,ZS,SZ
0110   183    FORMAT(1X,"XY-TERMS",
0111          X/," (A)  ",F13.4,5X,"  (B)",F13.4,6X,"  (AB)",F13.4,
0112          X/," (ABS)",F13.4,5X," (XY)",F13.4,/)
0113          WRITE(IUNIT,701)
0114   701    FORMAT(/////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
0115          110X,"SD",/)
0116          DO 704 I=1,P
0117          DO 704 J=1,Q
0118          JJ=(I-1)*Q+J
0119          XB1=SUMX(JJ)/XN
0120          SD1=DSQRT((SUMX2(JJ)-(SUMX(JJ)*SUMX(JJ))/XN)/(XN-1.))
0121   704    WRITE(IUNIT,705) I,J,N,SUMX(JJ),SUMX2(JJ),XB1,SD1
0122   705    FORMAT(1X,2I2,3X,I3,4(3X,F10.3))
0123          SA=(AZ-SZ)/DSQRT((AY-SY)*(AX-SX))
0124          AS=(BZ-SZ)/DSQRT((BY-SY)*(BX-SX))
0125          X=(ZS-SZ)/DSQRT((YS-SY)*(XS-SX))
0126          SN=(ZZ+SZ-AZ-BZ)/DSQRT((BA+SY-AY-BY)*(AB+SX-AX-BX))
0127          SNS=(ZS-ZZ)/DSQRT((YS-BA)*(XS-AB))
0128          Y=(EZ-AZ)/DSQRT((EY-AY)*(EX-AX))
0129          C=SY
0130          DD=SX
0131          ZI=SZ
0132          SY=YS-BA
0133          SX=XS-AB
0134          SZ=ZS-ZZ
0135          BA=BA+C-AY-BY
0136          AB=AB+DD-AX-BX
0137          ZZ=ZZ+ZI-AZ-BZ
0138          AY=AY-C
0139          AX=AX-DD
0140          AZ=AZ-ZI
0141          BY=BY-C
0142          BX=BX-DD
0143          BZ=BZ-ZI
0144          YS=YS-C
0145          XS=XS-DD
0146          ZS=ZS-ZI
0147          C=SY-SZ*SZ/SX
0148          AX=(AY+SY)-(AZ+SZ)*(AZ+SZ)/(AX+SX)-C
0149          BX=(BY+SY)-(BZ+SZ)*(BZ+SZ)/(BX+SX)-C
0150          AB=(BA+SY)-(ZZ+SZ)*(ZZ+SZ)/(AB+SX)-C
0151          XS=YS-ZS*ZS/XS
0152          J=N*P*Q-2
0153          D=P*Q*(N-1)-1
0154          P=P-1
0155          Q=Q-1
0156          I=P*Q
0157          AY=AX/P
```

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```
0158      BY=BX/Q
0159      BA=AB/I
0160      SX=C/D
0161      WRITE(IUNIT,545)
0162  545 FORMAT(/," 			SOURCE TABLE",/)
0163      WRITE(IUNIT,550)
0164  550 FORMAT(1X,"SOURCE",6X,"SS",10X,"DF",12X,"MS",12X,"F",11X,
0165      C"P(F)")
0166      AYSX=AY/SX
0167      DF1=P
0168      DF2=D
0169      F=AYSX
0170      CALL FPROB(F,DF1,DF2,Z,PF1)
0171      WRITE(IUNIT,555)AX,P,AY,AYSX,PF1
0172  555 FORMAT(//," A",5X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
0173      BYSX=BY/SX
0174      DF1=Q
0175      F=BYSX
0176      CALL FPROB(F,CF1,DF2,Z,PF2)
0177      WRITE(IUNIT,556)BX,Q,BY,BYSX,PF2
0178  556 FORMAT(" B",5X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
0179      BASX=BA/SX
0180      F=BASX
0181      TI=I
0182      CALL FPROB(F,TI,DF2,ZF3,PF3)
0183      WRITE(IUNIT,560)AB,I,BA,BASX,PF3
0184  560 FORMAT(" AB",4X,F13.3,5X,I3,5X,F13.3,3X,F11.5,3X,F10.5)
0185      WRITE(IUNIT,561)C,D,SX
0186  561 FORMAT(1X,"ERROR ",F13.3,5X,I3,5X,F13.3,/)
0187      WRITE(IUNIT,565)XS,J
0188  565 FORMAT(1X,"TOTAL ",F13.3,5X,I3,////)
0189      WRITE(IUNIT,811)
0190  811 FORMAT(1X,"CORRELATION COEFFICIENTS",/)
0191      WRITE(IUNIT,812)SA,AS
0192  812 FORMAT(1X,"A     ",F11.3,/,1X,"B     ",F11.3)
0193      WRITE(IUNIT,820)SN,SNS
0194  820 FORMAT(1X,"AB    ",F11.3,/,1X,"ERROR",F11.3)
0195      WRITE(IUNIT,821)X
0196  821 FORMAT(1X,"TOTAL",F11.3)
0197      CALL CLOSE(IB)
0198      STOP
0199      END
0200      END$
```

AC21B   (SPFAC-P.Q) (Two-way Split Plot Analysis of Covariance,
                              One Repeated Measure)

Purpose:

This program performs a two-way split-plot analysis of covariance
for one covariate.

Mathematical Model:

The model for this design is:

$$Y_{ijm(adj)} = Y_{ijm} - B'_b (\overline{X}_{ij.} - \overline{X}...) - B'_w (X_{ijm} - \overline{X}...) = u +$$

$$A_i - B_j + AB_{ij} + \Sigma_{m(i)} + B\Sigma_{jm(i)} + E_{ijm}$$

where:

Y_{ij} = unadjusted criterion measure

B'_b = between subject variation

B'_w = within subject variation

X_{ij} = covariate measure for subject i in the treatment population j

The hypotheses to be tested are:

Ho: A_i = 0 for all i

Ho: B_j = 0 for all j

Ho: AB_{ij} = 0 for all ij

Layout of Design:

	B_1		B_2		B_3	
	Y	X	Y	X	Y	X
A_1	S_1		S_1		S_1	
A_2	S_2		S_2		S_2	

1. There are two Factors (A and B) with p,q levels of treatments,
    respectively. Factor A is disignated as the between block or
    nonrepeated measure. Factor B is the within block or repeated
    measure. The above example includes two levels of Factor A,
    three levels of Factor B.

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2. Subjects from a common population are randomly assigned to
    the levels of Factor A. After this, levels of treatment B
    are assigned randomly to the subjects except when the nature
    of the repeated measure precludes randomization of the presen-
    tation order.

3. The experiment contains a source of variation believed to
    affect the dependent variable and is considered irrelevant
    to the objectives of the experiment. A measure of the extra-
    neous variation can be obtained which does not include effects
    attributable to the treatment.

4. The relationship of the dependent variable and the covariate
    is linear.

5. For repeated measures, the dependent measure for each subject
    is paired with a unique covariate measure. The covariate
    cannot be identical for all measures, e.g., age of the
    subject.

User Considerations and Procedures:

1. A data file must be created sequentially with two variables per
    record - the dependent variable (Y) first, then the covariate (X).
    On read input, vary the subject fastest, then B, and finally A.
    (For example, record one contains subject one for treatment and
    covariate of ab_{11}, record two is subject two, ab_{11}; continue for
    all subjects in treatment ab_{11}. Next, enter all subjects for
    treatment ab_{12}; repeat for ab_{1q}. Then enter data for ab_{21} . . .;
    the final record would be subject ab_{pq}.) A printout of raw data
    would show two data points per line.

2. The data analysis can either be displayed on the CRT or a hard-
    copy can be obtained from the line printer. Option: 1 for CRT
    output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw
    data printout is desired, 0 for no printout. The output device
    is designated by the above option (#2).

4. Parameters required:

    a. number of levels of Factor A (see comments)

    b. number of levels of Factor B (see comments)

c. number of subjects per level of Factor A (maximum 100)

d. name of data file

e. format of data file

5. Printout gives:

a. raw data by group (optional)

b. for each group: N, Σy, Σy^2, $\overline{Y}$, SD

c. ANOVA source table

d. intermediate calculations of the adjusted scores

e. correlation coefficients

Comments:

Analysis of covariance uses statistical control to reduce experimental error and obtain unbiased estimates of treatment effects. The procedure involves measuring the dependent variable and an additional covariate. The covariate represents a source of variation that has not been controlled in the experiment and is believed to affect the dependent variable. With analysis of covariance the dependent measure can be adjusted so as to remove the effects of the uncontrolled source of variation represented by the covariate.

Before comparisons among means can be made, the means must be adjusted for the covariate. The intermediate calculations given on the printout of the data must be used to adjust the means. Computational procedures and notation references can be found in Roger E. Kirk, Experimental Design Procedures for the Behavioral Sciences, Wadsworth Publishing Company, 1968, Pp. 482-485.

This program has the following restrictions:

1. The number of subjects for each level of A should be equal.

2. There cannot be more than 1,000 treatment combinations ($p*q \leq 1000$).

Test Data

This program was tested by comparing the results of the AC21B program to results obtained from a similar PDP 8/e Analysis of Covariance program. The program uses double precision in all calculations.

```
 RU,AC21B
AC21B OR
SPFAC-P,Q    ANALYSIS OF COVARIANCE TWO FACTORS MIXED
             DESIGN:  REPEATED MEASURES ON FACTOR B.  ON INPUT INDEX
             FOR SUBJECTS FIRST, THEN FOR WITHIN FACTOR B, THEN
             BETWEEN FACTOR A.  ENTER TWO POINTS PER LINE - DEPENDENT
             VARIABLE AND THEN THE COVARIATE
ENTER DATA FILE NAME
#JSPFA
ENTER DATA FORMAT
(2(2X,F8.4))
 ENTER THE RECORD LENGTH AS IN DA30
20
ENTER 1 FOR CRT DISPLAY, 6 FOR PRINTER
6
ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0
1
 HOW MANY LEVELS OF A?
3
 HOW MANY LEVELS OF B?
2
 SS/LEVEL OF A?
3
  AC21B  :  STOP    0000
 :
```

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Y	X
8.0000	3.0000
11.00C0	5.0000
16.0000	11.0000
14.0000	4.0000
18.0000	9.0000
22.0000	14.0000
6.0000	2.0000
12.0000	8.0000
9.0000	10.0000
8.0000	1.0000
14.0000	9.0000
10.0000	9.0000
10.0000	7.0000
14.0000	8.0000
15.0000	9.0000
10.0000	4.0000
18.0000	10.0000
22.0000	12.0000

Y-TERMS (DEPENDENT VARIABLE)

| (A) | 3220.5000 | (B) | 3188.5556 | (AB) | 3305.0000 |
| (ABS) | 3495.0000 | (Y) | 3120.5000 | (AS) | 3397.5000 |

X-TERMS (COVARIABLE)

| (A) | 1022.8333 | (B) | 1017.0000 | (AB) | 1034.3333 |
| (ABS) | 1233.0000 | (X) | 1012.5000 | (AS) | 1207.5000 |

XY-TERMS

| (A) | 1807.5000 | (B) | 1795.0000 | (AB) | 1835.6667 |
| (ABS) | 2004.0000 | (XY) | 1777.5000 | (AS) | 1964.0000 |

CELL		N	SUMX	SUMX2	MEAN	SD
1	1	3	35.000	441.000	11.667	4.041
1	2	3	54.000	1004.000	18.000	4.000
2	1	3	27.000	261.000	9.000	3.000
2	2	3	32.000	360.000	10.667	3.055
3	1	3	39.000	521.000	13.000	2.646
3	2	3	50.000	908.000	16.667	6.110

SOURCE TABLE

SOURCE	SS	DF	MS	F	P(F)
A	54.259	2.000	27.129	3.057	.136
ERROR	44.370	5.000	8.874		
B	31.547	1.000	31.547	52.613	.001
AB	2.339	2.000	1.170	1.951	.236
ERROR	2.998	5.000	.600		
TOTAL	141.837	15.			

CORRELATION COEFFICIENTS
A   .933
ERROR .866
B   1.000
AB   .994
ERROR .877

TOTAL .788

```
0001  FTN4
0002        PROGRAM AC21B
0003        INTEGER P,Q,D
0004        DOUBLE PRECISION BXX(100),BYY(100),EXX(100),EYY(100)
0005        DIMENSION IB(272),IBUF(256),NFILE(3),IFMT(20)
0006        DOUBLE PRECISION SUMX(1000),SUMX2(1000)
0007        DOUBLE PRECISION X,Y,SX,SY,ZS,YS,XS,SA,AS,SN,SSN,BA,AB,ZZ,AX,
0008       CAY,
0009       1AZ,ASQN,SAQN,EX,EY,EZ,SZ,BY,BZ,BX,BXPN,BYPN,C,DD,Z1,SK,D,AYBZ,
0010       1BYSX,BASX,PQN,PN,XN,QZ,FN
0011        DO 1054 I=1,100
0012        BXX(I)=0.
0013        BYY(I)=0.
0014        EXX(I)=0.
0015  1054  EYY(I)=0.
0016        WRITE(1,3999)
0017  3999  FORMAT("AC21B OR ",/,
0018       C"SPFAC-P.Q   ANALYSIS OF COVARIANCE   TWO FACTORS MIXED",/
0019       #,12X,"DESIGN : REPEATED MEASURES ON FACTOR B.  ON INPUT INDEX",
0020       $/,12X,"FOR SUBJECTS FIRST, THEN FOR WITHIN FACTOR B , THEN ",/,
0021       X12X,"BETWEEN FACTOR A. ENTER TWO POINTS PER LINE - DEPENDENT",
0022       %/,12X,"VARIABLE AND THEN THE COVARIATE",/,
0023       C"ENTER DATA FILE NAME ")
0024        READ(1,87) NFILE
0025  87    FORMAT(3A2)
0026        WRITE(1,99)
0027  99    FORMAT("ENTER DATA FORMAT ")
0028        READ(1,123) IFMT
0029  123   FORMAT(20A2)
0030        IDCBS=256
0031        CALL OPEN(IB,IER,NFILE,3,0,-2,IDCBS)
0032        IF (IER.GE.0) GO TO 546
0033        WRITE(1,430) NFILE,IER
0034  430   FORMAT(3A2," FAILED TO OPEN, IER = ",I5)
0035        STOP 430
0036  546   WRITE(1,209)
0037  209   FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR PRINTER")
0038        READ(1,*) IUNIT
0039        WRITE(1,219)
0040  219   FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
0041        READ(1,*) IPTO
0042        WRITE(1,4401)
0043  4401  FORMAT ( " HOW MANY LEVELS OF A? ")
0044        READ(1,*)  P
0045        WRITE(1,4402)
0046  4402  FORMAT ( "HOW MANY LEVELS OF B?  ")
0047        READ(1,*) Q
0048        WRITE(1,4403)
```

```
0049   4403    FORMAT ( " SS/LEVEL OF A?  ")
0050           READ(1,*) N
0051           XN=N
0052           PQN=P*Q*N
0053           QN=Q*N
0054           DO 250 I=1,P
0055           DO 330 J=1,Q
0056           IF(IPTO.EQ.1) WRITE(IUNIT,923)
0057   923     FORMAT(/)
0058           DO 440 K=1,N
0059           CALL READF(IB,IER,IBUF)
0060           CALL CODE
0061           READ(IBUF,IFMT) Y,X
0062           IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) Y,X
0063           SX=SX+X
0064           II=(I-1)*Q+J
0065           SUMX(II)=SUMX(II)+Y
0066           SUMX2(II)=SUMX2(II)+Y*Y
0067           SY=SY+Y
0068           ZS=ZS+X*Y
0069           YS=YS+Y*Y
0070           XS=XS+X*X
0071           SA=SA+X
0072           AS=AS+Y
0073           SN=SN+X
0074           SSN=SSN+Y
0075           BXX(J)=BXX(J)+X
0076           BYY(J)=BYY(J)+Y
0077           EXX(K)=EXX(K)+X
0078   440     EYY(K)=EYY(K)+Y
0079           BA=BA+SSN*SSN/XN
0080           AB=AB+SN*SN/XN
0081           ZZ=ZZ+SSN*SN/XN
0082           SNSN=SSN/XN
0083           SNN=SN/XN
0084           SN=0
0085   330     SSN=0
0086           AX=AX+SA*SA/QN
0087           AY=AY+AS*AS/QN
0088           AZ=AZ+SA*AS/QN
0089           ASQN=AS/QN
0090           SAQN=SA/QN
0091           QZ=Q
0092           PN=P*N
0093           DO 720 K=1,N
0094           EX=EX+EXX(K)*EXX(K)/QZ
0095           EY=EY+EYY(K)*EYY(K)/QZ
0096           EZ=EZ+EXX(K)*EYY(K)/QZ
0097           EXX(K)=0
0098   720     EYY(K)=0
0099           SA=0
0100   250     AS=0
0101           SZ=SY*SX/PQN
0102           SY=SY*SY/PQN
0103           SX=SX*SX/PQN
0104           DO 620 J=1,Q
```

```
0105        BY=BY+BYY(J)*BYY(J)/PH
0106        BX=BX+BXX(J)*BXX(J)/PH
0107        BZ=BZ+BXX(J)*BYY(J)/PH
0108        BYPH=BYY(J)/PH
0109        BXPH=BXX(J)/PH
0110  620   CONTINUE
0111        WRITE(IUNIT,170)
0112  170   FORMAT(/,1X," Y-TERMS (DEPENDENT VARIABLE)",/)
0113        WRITE(IUNIT,171)AY,BY,BA
0114  171   FORMAT(1X,"  (A)",F9.4,5X,"  (B)",F9.4,4X,"  (AB)",F9.4)
0115        WRITE(IUNIT,175)YS,SY,EY
0116  175   FORMAT(1X,"(ABS)",F9.4,5X,"  (Y)",F9.4,4X,"  (AS)",F9.4)
0117        WRITE(IUNIT,177)
0118  177   FORMAT(1X,/," X-TERMS (COVARIABLE)",/)
0119        WRITE(IUNIT,180)AX,BX,AB
0120  180   FORMAT(1X,"  (A)",F9.4,5X," (B)",F9.4,5X," (AB)",F9.4)
0121        WRITE(IUNIT,181)XS,SX,EX
0122  181   FORMAT(1X,"(ABS)",F9.4,5X,"  (X)",F9.4,5X," (AS)",F9.4)
0123        WRITE(IUNIT,185)
0124  185   FORMAT(1X," XY-TERMS",/)
0125        WRITE(IUNIT,186)AZ,BZ,ZZ
0126  186   FORMAT(1X,"  (A)",F9.4,5X,"  (B)",F9.4,5X," (AB)",F9.4)
0127        WRITE(IUNIT,190)ZS,SZ,EZ
0128  190   FORMAT(1X,"(ABS)",F9.4,5X," (XY)",F9.4,5X," (AS)",F9.4)
0129        WRITE(IUNIT,1270)
0130  1270  FORMAT(/////,"0  CELL",4X,"N",7X,"SUMX",6X,"SUMX2",9X,"MEAN",
0131       110X,"SD",/)
0132        DO 700 I=1,P
0133        DO 700 J=1,Q
0134        II=(I-1)*Q+J
0135        XB1=SUMX(II)/XN
0136        SD1=DSQRT((SUMX2(II)-(SUMX(II)*SUMX(II))/XN)/(XN-1.))
0137        WRITE(IUNIT,956) I,J,N,SUMX(II),SUMX2(II),XB1,SD1
0138  956   FORMAT(1X,2I3,2X,I3,4(3X,F10.3))
0139  700   CONTINUE
0140        SA=(AZ-SZ)/DSQRT((AY-SY)*(AX-SX))
0141        AS=(BZ-SZ)/DSQRT((BY-SY)*(BX-SX))
0142        X=(ZS-SZ)/DSQRT((YS-SY)*(XS-SX))
0143        SN=(ZZ+SZ-AZ-BZ)/DSQRT((BA+SY-AY-BY)*(AB+SX-AX-BX))
0144        SSN=(ZS+AZ-ZZ-EZ)/DSQRT((YS+AY-BA-EY)*(XS+AX-AB-EX))
0145        Y=(EZ-AZ)/DSQRT((EY-AY)*(EX-AX))
0146        C=SY
0147        DD=SX
0148        ZI=SZ
0149        SY=YS+AY-BA-EY
0150        SX=XS+AX-AB-EX
0151        SZ=ZS+AZ-ZZ-EZ
0152        EY=EY-AY
0153        EX=EX-AX
0154        EZ=EZ-AZ
0155        ZK=EY-EZ*EZ/EX
0156        BA=BA+C-AY-BY
0157        AB=AB+DD-AX-BX
0158        ZZ=ZZ+ZI-AZ-BZ
```

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```
0159          AY=AY-C
0160          AX=AX-DD
0161          AZ=AZ-ZI
0162          BY=BY-C
0163          BX=BX-DD
0164          BZ=BZ-ZI
0165          YS=YS-C
0166          XS=XS-DD
0167          ZS=ZS-ZI
0168          C=SY-SZ*SZ/SX
0169          AX=(AY+EY)-(AZ+EZ)*(AZ+EZ)/(AX+EX)-ZK
0170          BX=(BY+SY)-(BZ+SZ)*(BZ+SZ)/(BX+SX)-C
0171          AZ=ZK
0172          K=P*(N-1)-1
0173          BZ=AZ/K
0174          AB=(BA+SY)-(ZZ+SZ)*(ZZ+SZ)/(AB+SX)-C
0175          XS=YS-ZS*ZS/XS
0176          J=K*P*Q-3
0177          D=P*(Q-1)*(N-1)-1
0178          P=P-1
0179          Q=Q-1
0180          I=P*Q
0181          AY=AX/P
0182          BY=BX/Q
0183          BA=AB/I
0184          SX=C/D
0185          WRITE(IUNIT,545)
0186    545   FORMAT(12X,///,"                        SOURCE TABLE",//)
0187          WRITE(IUNIT,550)
0188    550   FORMAT(" SOURCE",5X,"SS",13X,"DF",7X,"MS",18X,"F",11X,"P(F)")
0189          AYBZ=AY/BZ
0190          TP=P
0191          TK=K
0192          F=AYBZ
0193          CALL FPROB(F,TP,TK,Z1,PF1)
0194          WRITE(IUNIT,555)AX,P,AY,AYBZ,PF1
0195    555   FORMAT(1X,"A      ",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
0196          WRITE(IUNIT,571)AZ,K,BZ
0197    571   FORMAT(1X,"ERROR ",3X,F7.3,5X,F7.3,5X,F7.3)
0198          BYSX=BY/SX
0199          F=BYSX
0200          DF1=Q
0201          DF2=D
0202          CALL FPROB(F,DF1,DF2,Z2,PF2)
0203          WRITE(IUNIT,556)BX,Q,BY,BYSX,PF2
0204    556   FORMAT(1X,"B      ",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
0205          BASX=BA/SX
0206          F=BASX
0207          DF1=I
0208          CALL FPROB(F,DF1,DF2,Z3,PF3)
0209          WRITE(IUNIT,560)AB,I,BA,BASX,PF3
0210    560   FORMAT(1X,"AB     ",3X,F7.3,5X,F7.3,5X,F7.3,8X,F7.3,8X,F7.3)
0211          WRITE(IUNIT,561)C,D,SX
0212    561   FORMAT(1X,"ERROR ",3X,F7.3,5X,F7.3,5X,F7.3,/)
0213          WRITE(IUNIT,565)XS,J
```

```
0214   565     FORMAT(1X,"TOTAL ",3X,F7.3,8X,I3,/)
0215           WRITE(IUNIT,810)SA,Y
0216   810     FORMAT(1X,"CORRELATION COEFFICIENTS",/," A    ",4X,F5.3,/," ERR
0217          XOR",4X,F5.3)
0218           WRITE(IUNIT,820)AS,SN,SSN
0219   820     FORMAT(1X,"B    ",4X,F5.3,/," AB   ",4X,F5.3,/," ERROR",4X,
0220          CF5.3,/)
0221           WRITE(IUNIT,999)X
0222   999     FORMAT(" TOTAL",4X,F5.3)
0223           CALL CLOSE(IB)
0224           STOP
0225           END
0226           END$
```

C. Multivariate Analysis of Variance

MAV10 (Multivariate One-way ANOVA)

Purpose:

This program performs a multivariate one-way analysis of variance.

Mathematical Model:

The model for this design is:

$$X_{ij(r)} = u_{(k)} + B_{j(r)} + E_{ij(r)}$$

The hypothesis to be tested is:

Ho: $B_{jr} = 0$ for all jr

Layout of Design:

1. Same as AV10 except each treatment has multiple dependent variables.

2. Each subject has r responses.

3. There are k levels of treatments.

4. Subjects are randomly assigned to the treatment levels with each subject designated to receive only one level.

5. Under each treatment, there are an equal number of (NR) observations.

User Considerations and Procedures:

1. A matrix data file must be created with r data points per line. On input, index observations under each treatment fastest, then treatment. (For example, the first record contains r responses for subject one, treatment b_1; second record contains r responses for subject two, treatment b_1. . ., then r responses for subject one, treatment b_2. . ., last record contains responses for subject n treatment b_k). A printout of raw data would show r data points per line.

2. The data analysis can either be displayed on the CRT or a hard copy can be obtained from the line printer. Option. 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

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4. A printout of the sums of squares and cross products matrix (error matrix) can be obtained. Option: 1 if printout desired, 0 for no printout.

5. Parameters required:

   a. number of treatments (maximum 20)

   b. number of responses per subject (maximum 30)

   c. number of subjects per treatment level (maximum 30)

   d. name of data file

   e. format of data file

6. Printout gives:

   a. raw data (optional)

   b. error matrix (optional)

   c. the U-statistic with degrees of freedom

   d. approximate F-value, degrees of freedom, and approximate alpha level

Test Data:

This program was tested using data from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp. 121-144.

```
RU, MAV10
 SU,4
      ONE-WAY MANOVA WITH NO RANDOMIZED BLOCKS

ENTER NAME OF YOUR DATA FILE
OMAV10
ENTER DATA FORMAT
(F4.1,1X,F3.1)
ENTER NUMBER OF TREATMENTS AND NUMBER OF VARIABLES
4,2
ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0
1
ENTER 1 FOR CRT, 6 FOR LINEPRINTER
1
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT          1
7
24.03.5
13.33.5
12.24.0
14.04.0
22.23.6
16.14.3
27.95.2
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT          2
7
 7.43.5
13.23.0
 8.53.0
10.13.0
 9.32.0
 8.32.5
 4.31.5
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT          3
5
16.43.2
24.02.5
53.01.5
32.72.6
42.82.0
ENTER NUMBER OF OBSERVATIONS FOR TREATMENT          4
2
25.12.7
 5.92.3
ENTER 1 FOR PRINTOUT OF ERROR MATRIX
1
           THE ERROR SS AND CP MATRIX
```

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```
ROW     1
  .13026794285D+04       -.176440000001D+02

ROW     2
  -.176440000000D+02       .677771428650+01

THE U-STATISTIC EQUALS          .159614113970+00

WITH DEGREES OF FREEDOM               2      3      20
THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM
          9.51913        6      38
 AND THE ALPHA LEVEL IS          .0000195
MAVO2 ABORTED
 :
```

```
MAV10    T=00003 IS ON CR00002 USING 00001 BLKS R=0000

0001     :SV,4
0002     :RP,MAV02
0003     :RU,MAV01
0004     :OF,MAV02
0005     :SV,0
```

```
0001   FTN4.L
0002          PROGRAM MAYO1
0003          DOUBLE PRECISION Y(30),T(20,30),G(30),H(30,30),E(30,30),
0004         1SUM,TH,SU,DET,DETH,T4,DF1,DF2
0005          INTEGER R
0006          COMMON I,J,R,H,E,DET,DETH,IUNIT,TH,T,G,Y,N(30),NAME(3),IFMT(20)
0007          COMMON IB(272),IBUF(256)
0008          DIMENSION NM(3)
0009          DATA NM/2HMA,2HYO,1H2/
0010          WRITE(1,1)
0011   1      FORMAT(5X,"ONE-WAY MANOVA WITH NO RANDOMIZED BLOCKS",/)
0012          WRITE(1,2)
0013   2      FORMAT("ENTER NAME OF YOUR DATA FILE")
0014          READ(1,3) NAME
0015   3      FORMAT(3A2)
0016          WRITE(1,4)
0017   4      FORMAT("ENTER DATA FORMAT")
0018          READ(1,5) IFMT
0019   5      FORMAT(20A2)
0020          CALL OPEN(IB,IER,NAME,3,0,0,256)
0021          IF(IER.GE.0) GO TO 10
0022          WRITE(1,6) NAME,IER
0023   6      FORMAT(3A2," FAILED TO OPEN, IER = ",I5)
0024          STOP
0025   10     WRITE(1,11)
0026   11     FORMAT("ENTER NUMBER OF TREATMENTS AND NUMBER OF VARIABLES")
0027          READ(1,*) J,R
0028   C      INTIALIZE ALL SS AND SCP AND SUMS
0029          NT=0
0030          DO 20 I=1,J
0031          DO 20 K=1,R
0032   20     T(I,K)=0.0D0
0033          DO 30 I=1,R
0034          G(I)=0.D0
0035          DO 30 K=1,R
0036          E(I,K)=0.D0
0037   30     H(I,K)=0.0D0
0038          WRITE(1,40)
0039   40     FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0")
0040          READ(1,*) IPTO
0041          WRITE(1,41)
0042   41     FORMAT("ENTER 1 FOR CRT, 6 FOR LINEPRINTER")
0043          READ(1,*) IUNIT
0044          DO 50 I=1,J
0045          WRITE(1,51) I
0046   51     FORMAT("ENTER NUMBER OF OBSERVATIONS FOR TREATMENT",I5)
0047          READ(1,*) N(I)
0048          TN=TN+N(I)
0049          IF((IPTO.EQ.1).AND.(IUNIT.EQ.6)) WRITE(6,52) I
0050   52     FORMAT(//,10X,"TREATMENT ",I5,/)
0051          DO 50 IV=1,N(I)
```

```
0052          CALL READF(IB,IER,IBUF)
0053          CALL CODE
0054          READ(IBUF,IFMT) (Y(K),K=1,R)
0055          IF(IPTO.EQ.1) WRITE(IUNIT,IFMT)(Y(K),K=1,R)
0056          DO 53 K=1,R
0057          T(I,K)=T(I,K)+Y(K)
0058          G(K)=G(K)+Y(K)
0059   53     CONTINUE
0060   50     CONTINUE
0061          CALL RWNDF(IB)
0062   C      CALCULATE H MATRIX
0063          DO 200 I=1,R
0064          DO 200 L=1,R
0065          SUM=0.D0
0066          DO 210 K=1,J
0067   210    SUM=SUM+T(K,L)*T(K,I)/N(K)
0068          E(I,L)=-SUM
0069   200    H(I,L)=SUM-G(I)*G(L)/TN
0070   C      CAL.   E MATRIX
0071          DO 300 I=1,R
0072          DO 300 L=1,R
0073          SU=0.D0
0074          DO 320 M=1,J
0075          DO 320 M1=1,N(M)
0076          CALL READF(IB,IR,IBUF)
0077          CALL CODE
0078          READ(IBUF,IFMT)(Y(IK),IK=1,R)
0079          SU=SU+Y(I)*Y(L)
0080   320    CONTINUE
0081          CALL RWNDF(IB)
0082   300    E(I,L)=E(I,L)+SU
0083          WRITE(1,157)
0084   157    FORMAT("ENTER 1 FOR PRINTOUT OF ERROR MATRIX")
0085          READ(1,*) IPTO
0086          IF(IPTO.NE.1) GO TO 507
0087   C      WRITE OUT E MATRIX
0088          WRITE(IUNIT,500)
0089   500    FORMAT(//10X,"THE ERROR SS AND CP MATRIX",/)
0090          DO 501 I=1,R
0091          WRITE(IUNIT,503) I
0092   503    FORMAT(/,5X,"ROW",I5)
0093    501   WRITE(IUNIT,502) (E(I,K),K=1,R)
0094   502    FORMAT(5(5X,D17.11))
0095   C      CREAT H+E MATQRIX     .... H
0096   507    DO 600 I=1,R
0097          DO 600 K=1,R
0098   600    H(I,K)=H(I,K)+E(I,K)
0099          CALL CLOSE(IB)
0100          CALL EXEC(9,NM)
0101          END
0102          END$
```

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```
0001   FTN4,L
0002         PROGRAM MAV02
0003         INTEGER R
0004         DOUBLE PRECISION H(30,30),E(30,30),DET,DETH,SU,SUM,T4,DF1,DF2
0005         DOUBLE PRECISION TN
0006         COMMON I,J,R,H,E,DET,DETH,IUNIT,TN
0007         CALL MINV(H,R,DETH)
0008         CALL MINV(E,R,DET)
0009         DET=DET/DETH
0010         I1=J-1
0011         I2=TN-1
0012         I3=TN-2
0013         WRITE(IUNIT,800) DET
0014   800   FORMAT(//,5X,"THE U-STATISTIC EQUALS",5X,D16.11)
0015         WRITE(IUNIT,802) R,I1,I2
0016   802   FORMAT(/,5X,"WITH DEGREES OF FREEDOM   ",3(I7))
0017   C     FIND APPROX. F LEVEL
0018         IF(R.NE.2) GO TO 900
0019         DETH=(1-DSQRT(DET))/DSQRT(DET)
0020         D=DETH*I3/I1
0021         E1=2*I1
0022         DE=2*(I2-1)
0023         GO TO 901
0024   900   SUM=R*R+(J-1)*(J-1)
0025         SU=1
0026         IF(SUM.LE.5.0D0) GO TO 801
0027         SU=DSQRT((R*R*(J-1)*(J-1)-4.)/(SUM-5.))
0028   801   T4=TN-1-(J+R)/2.
0029         DETH=DET**(1./SU)
0030         DF1=R*(J-1)
0031         DF2=1+T4*SU-R*(J-1)/2.
0032         DETH=((1.-DETH)/DETH)*DF1/DF2
0033   C     USE SINGLE PREICSION IN CALL TO FPROB
0034         D=DETH
0035         E1=DF1
0036         DE=DF2
0037   901   CALL FPROB(D,E1,DE,SD,FPR)
0038         WRITE(IUNIT,902) D,E1,DE,FPR
0039   902   FORMAT(//," THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM "
0040         &,/," = ",5X,F10.5,2(I7),/," AND THE ALPHA LEVEL IS",
0041         %5X,F10.7)
0042         END
0043         END$
```

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MAV11 (Multivariate Two-way ANOVA, Repeated Measures)

Purpose:

This program performs a multivariate one-way analysis of variance
with replication either using matched subjects or by repeated
measures.

Mathematical Model:

The model for this analysis is:

$$X_{ij(r)} = U_{(r)} + \pi_{i(r)} + B_{j(r)} + E_{ij(r)}$$

The hypothesis to be tested is:

Ho: $B_{jr} = 0$ for all jr

Layout of Design:

1. Same as AV11 except each treatment has multiple dependent
   variables

2. Each subject has r responses

3. There are k levels of treatment B

4. Subjects are assigned to a treatment so that variability within
   a treatment is less than the variability among treatments. Homo-
   genity within treatments may be achieved by using a subject as
   his own control or by using subjects matched on the basis of a
   variable that correlates with the dependent variable

5. Under each treatment there are equal number (NR) observations

User Considerations and Procedures:

1. A matrix data file must be created with r responses per record.
   On input, index responses fastest, then subjects, and treatment
   slowest. (For example, first record contains r responses for
   subject one, treatment b_1; second record contains r responses
   for subject two, treatment b_1. . ., then r responses for subject
   one, treatment b_2. . ., the last record contains the r responses
   for subject N, treatment b_k.) A printout would show r data
   points per line.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. A printout of the sums of squares and cross product matrix (error matrix) can be obtained. Option: 1 if printout is desired, 0 for no printout.

5. Parameters required:

    a. number of subjects (maximum 20)

    b. number of treatments (maximum 20)

    c. number of responses per subject (maximum 30)

    d. name of data file

    e. format of data file

6. Printout gives:

    a. raw data (optional)

    b. error matrix (optional)

    c. block (subject) totals for each dependent variable

    d. treatment totals for each dependent variable

    e. the U-statistics with degrees of freedom

    f. approximate F-test with degrees of freedom and alpha level

Comments:

Mount a scratch tape before running program.

Test Data:

This program was tested from Clyde Kramer's, A First Course in Multivariate Analysis, Clyde Kramer, Publisher, 1972, Pp 145-158.

```
RU, MAV11
 SU,4
PROGRAM TO PERFORM ONE-WAY MANOVA WITH
REPEATED MEASURES (OR RANDOMIZED BLOCKS)

ENTER NAME OF DATA FILE
#MAV11
ENTER FORMAT OF FILE
(3(2X,F3.0))
ENTER NUMBER OF BLOCKS, TREATMENTS, AND VARIATES
4,5,3
ENTER 1 FOR LISTING OF RAW DATA, ELSE ENTER Ø
1
ENTER 1 FOR ERROR MATRIX PRINTOUT, ELSE ENTER Ø
1
ENTER 1 FOR CRT, OR 6 FOR LINE PRINTER OUTPUT
6

ENTER 1 FOR PRINTOUT OF TREATMENT AND BLOCK TOTALS
1
MAV1B ABORTED
MAV1C ABORTED
```

RAW DATA

TREATMENT   1

96.	10.	725
142.	16.	700
122.	13.	655
111.	13.	680

TREATMENT   2

102.	15.	695
106.	10.	710
95.	14.	705
93.	12.	680

TREATMENT   3

109.	15.	690
113.	15.	690
101.	14.	680
100.	19.	685

TREATMENT   4

103.	17.	680
97.	16.	690
99.	13.	730
135.	12.	670

TREATMENT   5

98.	17.	680
97.	14.	695
105.	16.	680
86.	22.	710

PRINTOUT OF BLOCK TOTALS

508.00000	74.00000	3470.00000
555.00000	71.00000	3485.00000
522.00000	70.00000	3450.00000
525.00000	78.00000	3425.0000

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PRINTOUT OF TREATMENT TOTALS

471.00000	52.00000	2760.00000
396.00000	51.00000	2790.00000
423.00000	63.00000	2745.00000
434.00000	58.00000	2770.00000
386.00000	69.00000	2765.00000

THE ERROR SS AND CP MATRIX IS

.22589000001D+04	-.2464999998D+02	-.16582500000D+04
-.2464999998D+02	.91500000000D+02	.40000000000D+01
-.16582500000D+04	.40000000000D+01	.55325000000D+04

THE U-STATISTIC EQUALS   .3990056930
WITH DESGREES OF FREEDOM   3   4   12

THE APPROXIMATE F VALUE, DEGREES OF FREEDOM,
=   1.20013   12   35
AND THE ALPHA LEVEL IS   .3212206

```
MAV11    T-00004 IS ON CR00002 USING 00001 BLKS R=0009

0001    :SV,4
0002    :CN
0003    :RP,MAV1B
0004    :RP,MAV1C
0005    :RU,MAV1A
0006    :OF,MAV1B
0007    :OF,MAV1C
0008    :CN
0009    :SV,0
0010    :
```

```
0001   FTH4,L
0002          PROGRAM MAV1A
0003          DOUBLE PRECISION Z(30)
0004          INTEGER B,T,P
0005          COMMON B,T,P,IUNIT,IPT,IPT1,IFMT(20),IBUF(256),IB(272),Z
0006          DIMENSION NM(3),NAME(3)
0007          DATA NM/2HMA,2HV1,1HB/
0008          REWIND 8
0009          WRITE(1,1)
0010   1      FORMAT("PROGRAM TO PERFORM ONE-WAY MANOVA WITH ",/,
0011          &"REPEATED MEASURES ( OR RANDOMIZED BLOCKS)",//)
0012          WRITE(1,2)
0013   2      FORMAT("ENTER NAME OF DATA FILE")
0014          READ(1,3) NAME
0015   3      FORMAT(3A2)
0016          WRITE(1,4)
0017   4      FORMAT("ENTER FORMAT OF FILE")
0018          READ(1,5) IFMT
0019   5      FORMAT(20A2)
0020          WRITE(1,6)
0021   6      FORMAT("ENTER NUMBER OF BLOCKS,TREATMENTS, AND VARIATES")
0022          READ(1,*) B,T,P
0023          CALL OPEN(IB,IER,NAME,3,0,0,272)
0024          IF(IER.GE.0) GO TO 20
0025          WRITE(1,7) NAME,IER
0026   7      FORMAT(3A2,5X,"FAILED TO OPEN, IER = ",I5)
0027          STOP 7777
0028   20     WRITE(1,21)
0029   21     FORMAT("ENTER 1 FOR LISTING OF RAW DATA, ELSE ENTER 0")
0030          READ(1,*) IPTO
0031          WRITE(1,22)
0032   22     FORMAT("ENTER 1 FOR ERROR MATRIX PRINTOUT, ELSE ENTER 0")
0033          READ(1,*) IPT
0034          WRITE(1,23)
0035   23     FORMAT("ENTER 1 FOR CRT, OR 6 FOR LINEPRONTER OUTPUT")
0036          READ(1,*) IUNIT
0037          IF(IPTO.EQ.1) WRITE(IUNIT,24)
0038   24     FORMAT(//,5X,"RAW DATA",/)
0039          DO 30 I=1,T
0040          IF(IPTO.EQ.1) WRITE(IUNIT,25) I
0041   25     FORMAT(/,10X,"TREATMENT ",I7)
0042          DO 30 J=1,B
0043          CALL READF(IB,IER,IBUF)
0044          CALL CODE
0045          READ(IBUF,IFMT) (Z(K),K=1,P)
0046          IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (Z(K),K=1,P)
0047   30     WRITE(8,IFMT) (Z(K),K=1,P)
0048          ENDFILE 8
0049          REWIND 8
0050          CALL CLOSE(IB)
0051          WRITE(1,60)
0052   60     FORMAT(//,"ENTER 1 FOR PRINTOUT OF TREATMENT AND BLOCK TOTALS")
0053          READ(1,*) IPT1
0054          CALL EXEC(9,NM)
0055          END
0056          END$
```

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```
0001   FTN4,L
0002          PROGRAM MAV1B
0003          DOUBLE PRECISION B1(20,30),T1(20,30),G(30),H(30,30),E(30,30),
0004         &Y(30),BL,BK,TI,SUM
0005          INTEGER B,T,P
0006          COMMON B,T,P,IUNIT,IPT,ITP1,IFMT(20),H,E,B1,H1,G,Y
0007          DIMENSION NM(3)
0008          DATA NM/2HMA,2HV1,1HC/
0009          DO10 I=1,20
0010          DO10 J=1,30
0011          G(J)=0.D0
0012          B1(I,J)=0.D0
0013   10     T1(I,J)=0.D0
0014          CALL ENDIO
0015          DO 30 I=1,T
0016          DO 30 J=1,B
0017          READ(8,IFMT) (Y(II),II=1,P)
0018          DO 30 K=1,P
0019          B1(J,K)=B1(J,K)+Y(K')
0020   30     T1(I,K)=T1(I,K)+Y(K)
0021          REWIND 8
0022          DO 40 K=1,P
0023          DO 40 I=1,B
0024   40     G(K)=G(K)+B1(I,K)
0025          BI=B
0026          BK=B*T
0027          TI=T
0028          IF(ITP1.NE.1) GO TO 41
0029          WRITE(IUNIT,42)
0030   42     FORMAT(//,5X,"PRINTOUT OF BLOCK TOTALS",/)
0031          DO 44 I=1,B
0032          WRITE(IUNIT,43)
0033   43     FORMAT(5X)
0034   44     WRITE(IUNIT,45)(B1(I,K),K=1,P)
0035   45     FORMAT(5(3X,F13.5))
0036          WRITE(IUNIT,46)
0037   46     FORMAT(///,5X,"PRINTOUT OF TREATMENT TOTALS",/)
0038          DO 47 I=1,T
0039          WRITE(IUNIT,43)
0040   47     WRITE(IUNIT,45) (T1(I,K),K=1,P)
0041   41.    CONTINUE
0042          DO 50 I=1,P
0043          DO 50 J=1,P
0044          SUM=0.D0
0045          DO 60 K=1,T
0046   60     SUM=SUM+T1(K,I)*T1(K,J)
0047          H(I,J)=SUM/BI-G(I)*G(J)/BK
0048          E(I,J)=-H(I,J)
0049          SUM=0.D0
0050          DO 70 K=1,B
```

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```
0051    70      SUM=SUM+B1(K,I)*B1(K,J)
0052            E(I,J)=E(I,J)-SUM/TI
0053            SUM=0.D0
0054            DO 90 I1=1,T
0055            DO 90 J1=1,B
0056            CALL ENDIO
0057            READ(8,IFMT) (Y(K),K=1,P)
0058    90      SUM=SUM+Y(I)*Y(J)
0059            E(I,J)=E(I,J)+SUM
0060            REWIND 8
0061    50      CONTINUE
0062    C       H,E MATRIX COMPLETE OPTION FOR PRINT OF E
0063            IF(IPT.EQ.0) GO TO 100
0064            WRITE(IUNIT,500)
0065    500     FORMAT(//,10X,"THE ERROR SS AND CP MATRIX IS ",/)
0066            DO501 I=1,P
0067            WRITE(IUNIT,43)
0068    501     WRITE(IUNIT,502) (E(I,J),J=1,P)
0069    502     FORMAT(4(4X,D16.11))
0070    C       CREAT H+E   STORE IN H
0071    100     DO600 I=1,P
0072            DO600 J=1,P
0073    600     H(I,J)=H(I,J)+E(I,J)
0074    C       FINISHED WITH THIS PART
0075            CALL EXEC(9,NM)
0076            END
0077            END$
```

```
0001   FTN4,L
0002          PROGRAM MAV1C
0003          DOUBLE PRECISION H(30,30),E(30,30),DET,DET1,U,F
0004          DOUBLE PRECISION SUM,SU,T4,DF1
0005          INTEGER B,T,P
0006          COMMON B,T,P,IUNIT,ITP,ITP1,IFMT(20),H,E
0007          CALL MINV(E,P,DET)
0008          CALL MINV(H,P,DET1)
0009          U=DET/DET1
0010   C      THE U-STATISTIC WITH DF P,I1,I2
0011          I1=T-1
0012          I2=(B-1)*I1
0013          I3=B*T
0014   C      I1=DEGREES OF FREEDOM FOR HYPOTH    I2=DF FOR ERROR
0015   C      I3=TOTAL SAMPLE SIZE
0016          WRITE(IUNIT,100) U,P,I1,I2
0017   100    FORMAT(///,5X,"THE U-STATISTIC EQUALS",5X,F15.10,/,
0018          $5X,"WITH DEGREES OF FREEDOM ",3(5X,I7))
0019   C      NEXT TO CAL APPOX. F-VAULE
0020   C      CHECK FOR EXACT F-VALUE
0021          IF(P.NE.2) GO TO 200
0022          DET=DSQRT(U)
0023          DET=(1-DET)/DET
0024          D=DET*(I2-1)/I1
0025   C      D=EXACT F VALUE
0026          E1=I1*2
0027          DE=2*(I2-1)
0028   C      CALL FPROB
0029          GO TO 300
0030   200    SUM=P*P+I1*I1
0031          SU=1.D0
0032          IF(SUM.LE.5.D0) GO TO 210
0033          SU=DSQRT((P*P*I1*I1-4.D0)/(SUM-5.D0))
0034    210   T4=I3-1-(T+P)/2.D0
0035          DET1=U**(1.D0/SU)
0036          DF1=P*I1
0037          DET=1+T4*SU-DF1/2.D0
0038          U=((1.D0-DET1)/DET1)*(DET/DF1)
0039   C      USE SINGLE PRECISION ON FPROB CAL
0040          D=U
0041          E1=DF1
0042          DE=DET
0043   C      D,E1,DE === F-VALUE,DEGREES OF FREEDOM
0044   C      FPR= ALPHA - LEVEL
0045   300    CALL FPROB(D,E1,DE,SD,FPR)
0046          WRITE(IUNIT,902) D,E1,DE,FPR
0047   902    FORMAT(//," THE APPROXIMATE F-VALUE, DEGREES OF FREEDOM,"
0048          &,/," = ",5X,F10.5,2(I7),/," AND THE ALPHA LEVEL IS",
0049          %5X,F10.7)
0050          END
0051          END$
```

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MAV20   (Multivariate Two-way ANOVA)

Purpose:

> This program performs a two-way multivariate completely randomized analysis of variance.

Mathematical Model:

> The model for this analysis is:

$$X_{ijk(r)} = M_{(r)} + A_{i(r)} + B_{j(r)} + AB_{ij(r)} + E_{ijk(r)}$$

> The hypotheses to be tested are:

> Ho: $A_{ir} = 0$ for all ir
>
> Ho: $B_{jr} = 0$ for all jr
>
> Ho: $AB_{ijr} = 0$ for all ijr

Layout of Design:

1. Same design as AV20, except each Factor has multiple dependent variables

2. Each subject has r responses

3. There are two factors (A,B) with p and q levels of treatments

4. ubjects are randomly assigned to the pq treatment combinations, with each subject receiving only one combination

5. There are an equal number of observations for each AB cell

User Considerations and Procedures:

1. A matrix data file must be created with r responses per record. On input subjects vary fastest, then factor B, and finally A. (For example, first record contains r responses for subject one, treatment ab_{11}, second record contains r responses for subject two, treatment ab_{11}. . . ., then r responses for subject one, treatment ab_{12}. . ., then r responses for subject one, treatment ab_{21}. . ., final record would be r responses for subject k for treatment ab_{pq}.) A printout of raw data would show r data points per line.

2. The data analysis can be displayed on the CRT or a hardcopy
   can be obtained from the line printer. Option: 1 for CRT
   output, 6 for line printer output.

3. A printout of raw data can be obtained. Option: 1 if raw data
   printout is desired, 0 for no printout. The output device is
   designated by the above option (#2).

4. The printout of the sums of squares and cross product matrix
   (error matrix) can be obtained. Option: 1 if desired, 0 for
   no printout.

5. Parameters required:

   a. number of levels of Factor A (maximum 20)

   b. number of levels of Factor B (maximum 20)

   c. number of subjects per AB cell (maximum 32767)

   d. number of responses (r)

   e. name of data file

   f. format of data file

6. Printout gives:

   a. raw data (optional)

   b. error matrix (optional)

   c. cell totals

   d. the U-statistics with degrees of freedom

Test Data:

   Program was tested from Clyde Kramer's, A First Course in Multivariate
   Analysis, Clyde Kramer, Publisher, 1972, Pp. 164-187.

```
RU,MAV20
TWO WAY MULTIVARIATE ANALYSIS OF VARIANCE

ENTER NAME OF RAW DATA FILE
#MAV20
ENTER FORMAT OF DATA
(3X,F4.1,2X,F5.1,2X,F4.1)
ENTER NUMBER OF LEVELS OF FACTOR A, FACTOR B, NUMBER OF VARIATES, AND
NUMBER OF OBSERVATIONS PER A,B TREATMENT CELL
2,3,3,4
ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER
6
ENTER 1 FOR RAW DATA LISTING, ELSE ENTER Ø
1
ENTER 1 FOR PRINTOUT OF ERROR MATRIX, ELSE ENTER Ø
1
ENTER 1 FOR PRINTOUT OF FACTOR TOTALS
1
```

RAW DATA

                    TREATMENT PAIR   1   1
40.1   85.6   46.8
41.1   83.2   41.7
40.9   79.5   38.1
39.4   78.0   39.6
CELL TOTALS
       .161500000000D+03   .326300000000D+03   .166200000000D+03

                    TREATMENT PAIR   1   2
63.0   102.4   44.8
61.9   100.3   39.4
61.6   101.3   39.9
64.0   106.2   50.0
CELL TOTALS
       .250500000000D+03   .410200000000D+03   .174100000000D+03

                    TREATMENT PAIR   2   1
52.8   114.4   47.1
53.6   115.6   42.1
53.9   114.2   42.3
53.8   113.2   35.7
CELL TOTALS
       .214100000000D+03   .457400000000D+03   .167200000000D+03

                    TREATMENT PAIR   2   2
68.6   129.3   42.7
70.7   131.0   47.1
69.1   135.8   45.2
73.3   147.6   49.2
CELL TOTALS
       .281700000000D+03   .544200000000D+03   .184200000000D+03

                    TREATMENT PAIR   3   1
41.6   142.3   45.8
37.7   137.0   37.0
43.2   143.8   44.0
42.0   143.6   40.8
CELL TOTALS
       .164500000000D+03   .566700000000D+03   .167600000000D+03

                    TREATMENT PAIR   3   2
62.8   164.4   44.4
56.6   156.0   45.3
63.3   161.3   46.3
60.9   161.4   42.2
CELL TOTALS
       .243600000000D+03   .643100000000D+03   .178200000000CD+03

ERROR MATRIX
ROW #   1
.64497499943D+02   .10466500044D+03   .48837500215D+02
ROW #   2
.10466500044D+03   .32391249943D+03   .15558500028D+03
ROW #   3
.48837500215D+02   .15558500028D+03   .25961750042D+03

ROW TREATMENT TOTALS

ROW #   1
.41200000000D+03   .73650000000D+03   .34030000000D+03
ROW #   2
49580000000D+03   .10016000000D+04   .35140000000D+03
ROW #   3
.40810000000D+03   .12098000000D+04   .34580000000D+03

COLUMN TREATMENT TOTALS

COLUMN   1
.54010000000D+03   .13504000000D+04   .50100000000D+03
COLUMN   2
.77580000000D+03   .15975000000D+04   .53650000000D+03

HYPOTHESIS TEST RESULTS

HYPOTHESIS OF	U-STATISTIC	DEGREES OF FREEDOM		
INTERACTION EFFECT	.47183408163D+00	3	2	18
FACTOR A EFFECT	.774734711183D-03	3	1	18
FACTOR B EFFECT	.23177578747D-01	3	2	18

```
0001   FTN4,L
0002          PROGRAM MAV20
0003          INTEGER C,R,P
0004          DOUBLE PRECISION RIJ(30,30),G(30),X(30),SUM(30),RN,RCN,CN,SU
0005          DOUBLE PRECISION E(30,30),DETE,DET1,DET2,DET3
0006          COMMON C,R,P,N,IPT,IUNIT,RIJ,IFMT(20),IB(272),IBUF(256),
0007         $NAME(3),X,SUM,E
0008          EQUIVALENCE (G,SUM)
0009          REWIND 8
0010          WRITE(1,1)
0011   1      FORMAT("TWO WAY MULTIVARIATE ANALYSIS OF VARIANCE",/
0012         $/,"ENTER NAME OF RAW DATA FILE")
0013          READ(1,2) NAME
0014   2      FORMAT(3A2)
0015          CALL OPEN(IB,IER,NAME,3,0,0,272)
0016          IF(IER.GE.0) GO TO 20
0017   323    WRITE(1,3) NAME,IER
0018   3      FORMAT(3A2,"  FAILED TO OPEN, IER = ",I5)
0019          STOP
0020   20     WRITE(1,5)
0021   5      FORMAT("ENTER FORMAT OF DATA")
0022          READ(1,6) IFMT
0023   6      FORMAT(20A2)
0024          WRITE(1,7)
0025   7      FORMAT("ENTER NUMBER OF LEVELS OF FACTOR A, FACTOR B,",
0026         $"NUMBER OF VARIATES, AND ",/,"NUMBER OF OBSERVATIONS PER ",
0027         %"A,B TREATMENT CELL ")
0028          READ(1,*) C,R,P,N
0029          WRITE(1,14)
0030   14     FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LINEPRINTER")
0031          READ(1,*) IUNIT
0032          WRITE(1,15)
0033   15     FORMAT("ENTER 1 FOR RAW DATA LISTING, ELSE ENTER 0")
0034          READ(1,*) IPTO
0035          WRITE(1,16)
0036   16     FORMAT("ENTER 1 FOR PRINTOUT OF ERROR MATRIX, ELSE ENTER 0")
0037          READ(1,*) IPT
0038          WRITE(1,17)
0039   17     FORMAT("ENTER 1 FOR PRINTOUT OF FACTOR TOTALS")
0040          READ(1,*) IPT1
0041          IF(IPTO.EQ.1)  WRITE(IUNIT,13)
0042   13     FORMAT(//,5X,"RAW DATA",/)
0043          CALL ENDIO
0044          DO 30 I=1,R
0045          DO 30 J=1,C
0046          DO 40 K=1,N
0047   40     SUM(K)=0.D0
0048          IF(IPTO.EQ.1) WRITE(IUNIT,11) I,J
0049   11     FORMAT(15X,"TREATMENT PAIR ",2I7)
0050          DO 50 K=1,N
```

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```
0051        CALL READF(IB,IER,IBUF)
0052        CALL CODE
0053        READ(IBUF,IFMT) (X(I1),I1=1,P)
0054        IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (X(I1),I1=1,P)
0055        DO 50 I1=1,P
0056    50  SUM(I1)=SUM(I1)+X(I1)
0057        WRITE(8,51) (SUM(I1),I1=1,P)
0058    51  FORMAT(30D16.11)
0059        IF(IPT1.NE.1) GO TO 30
0060        WRITE(IUNIT,123)
0061    123 FORMAT(" CELL TOTALS")
0062        WRITE(IUNIT,522) (SUM(I1),I1=1,P)
0063        WRITE(IUNIT,533)
0064    522 FORMAT(5X,4(3X,D16.11))
0065    533 FORMAT(5X)
0066    30  CONTINUE
0067        CALL RWNDF(IB)
0068    C   NOW CREAT 000XIJKU*XIJKV INTO RIJ MTX
0069        REWIND 0
0070        CALL INIT(RIJ)
0071        DO 300 I=1,P
0072        DO 300 J=1,P
0073        SU=0.D0
0074        DO 400 L3=1,R
0075        DO 400 L1=1,C
0076        DO 400 L2=1,N
0077        CALL READF(IB,IER,IBUF)
0078        CALL CODE
0079        READ(IBUF,IFMT) (X(I1),I1=1,P)
0080    400 SU=SU+X(I)*X(J)
0081        RIJ(I,J)=SU
0082        CALL RWNDF(IB)
0083    300 CONTINUE
0084    C   CREAT ERROR MATRIX
0085        CALL INIT(E)
0086        CALL ENDIO
0087        DO 500 I=1,P
0088        DO 501 J=1,P
0089        SU=0.D0
0090        DO 600 K=1,R
0091        DO 600 L=1,C
0092        READ(8,51) (X(I1),I1=1,P)
0093        SU=SU+X(I)*X(J)
0094    600 CONTINUE
0095        REWIND 8
0096        CALL ENDIO
0097    501 E(I,J)=RIJ(I,J)-SU/N
0098    500 CONTINUE
0099        IF(IPT.NE.1) GO TO 564
0100        WRITE(IUNIT,565)
0101    565 FORMAT(///,5X,"ERROR MATRIX")
0102        DO 156 I=1,P
```

```
0103          WRITE(IUNIT,52) I
0104   156    WRITE(IUNIT,53) (E(I,J),J=1,P)
0105   564    REWIND 8
0106          CALL RWNDF(IB)
0107          CALL INIT(RIJ)
0108          DO 101 I=1,30
0109   101    G(I)=0.D0
0110          DO 100 I=1,R
0111          DO 100 J=1,C
0112          DO 100 K=1,N
0113          CALL READF(IB,IER,IBUF)
0114          CALL CODE
0115          READ(IBUF,IFMT) (X(I1),I1=1,P)
0116          DO 100 L=1,P
0117          G(L)=G(L)+X(L)
0118          RIJ(I,L)=RIJ(I,L)+X(L)
0119   100    CONTINUE
0120          IF(IPT1.NE.1) GO TO 36
0121          WRITE(IUNIT,37)
0122   37     FORMAT(///,"      ROW TREATMENT TOTALS",//)
0123          DO 110 I=1,R
0124          WRITE(IUNIT,52) I
0125   52     FORMAT(5X,"ROW # ",I5)
0126   110    WRITE(IUNIT,53) (RIJ(I,J),J=1,P)
0127   53     FORMAT(4(4X,D16.11))
0128   36     RH=R*H
0129          CN=C*N
0130          RCN=R*C*N
0131          CALL ENDIO
0132          DO 200 I=1,P
0133          DO 200 J=1,P
0134          SU=0.D0
0135          DO 202 K=1,R
0136   202    SU=SU+RIJ(K,I)*RIJ(K,J)
0137          SU=SU/CN-G(I)*G(J)/RCN
0138          WRITE(8,511) SU
0139   511    FORMAT(D20.13)
0140   200    CONTINUE
0141          CALL RWNDF(IB)
0142          REWIND 8
0143          CALL ENDIO
0144          DO 203 I=1,P
0145          DO 203 J=1,P
0146          READ(8,511) RIJ(I,J)
0147   203    RIJ(I,J)=RIJ(I,J)+E(I,J)
0148          CALL HINV(RIJ,P,DET2)
0149          CALL INIT(RIJ)
0150          DO 92 I=1,R
0151          DO 92 J=1,C
0152          DO 92 K=1,N
0153          CALL READF(IB,IER,IBUF)
0154          CALL CODE
0155          READ(IBUF,IFMT) (X(I1),I1=1,P)
0156          DO 92 L=1,P
0157   92     RIJ(J,L)=RIJ(J,L)+X(L)
0158          IF(IPT1.NE.1) GO TO 38
```

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```
0159        WRITE(IUNIT,35)
0160   35   FORMAT(///,5X,"COLUMN TREATMENT TOTALS",///)
0161        DO 210 I=1,C
0162        WRITE(IUNIT,39) I
0163   39   FORMAT(5X,"COLUMN",I7)
0164  210   WRITE(IUNIT,53) (RIJ(I,J),J=1,P)
0165   38   DO 94 I=1,P
0166        DO 94 J=1,P
0167        SU=0.DO
0168        DO 95 K=1,C
0169   95   SU=SU+RIJ(K,I)*RIJ(K,J)
0170        SU=SU/RN-G(I)*G(J)/RCN
0171        WRITE(8,511) SU
0172   94   CONTINUE
0173        CALL RWNDF(IB)
0174        REWIND 8
0175        J2=P*P
0176        CALL ENDIO
0177        DO 912 I=1,J2
0178  912   READ(8,511) SU

0179        DO 99 I=1,P
0180        DO 99 J=1,P
0181        READ(8,511) RIJ(I,J)
0182   99   RIJ(I,J)=RIJ(I,J)+E(I,J)
0183        REWIND 8
0184        CALL MINV(RIJ,P,DET3)
0185        CALL INIT(RIJ)
0186   C    SUB H1,H2,E FROM TOTAL GET HE STORE IN TIJ
0187        DO 3000 I=1,P
0188        DO 3000 J=1,P
0189        SU=0.DO
0190        DO 4000 L3=1,R
0191        DO 4000 L1=1,C
0192        DO 4000 L2=1,N
0193        CALL READF(IB,IER,IBUF)
0194        CALL CODE
0195        READ(IBUF,IFMT) (X(I1),I1=1,P)
0196 4000   SU=SU+X(I)*X(J)
0197        RIJ(I,J)=SU-G(I)*G(J)/RCN
0198        CALL RWNDF(IB)
0199 3000   CONTINUE
0200        CALL CLOSE(IB)
0201        CALL ENDIO
0202        DO 1001 I1=1,2
0203        DO 1001 I=1,P
0204        DO 1001 J=1,P
0205        READ(8,511) X(1)
0206 1001   RIJ(I,J)=RIJ(I,J)-X(1)
0207        CALL MINV(RIJ,P,DET1)
0208        CALL MINV(E,P,DETE)
0209        DET1=DETE/DET1
0210        DET2=DETE/DET2
0211        DET3=DETE/DET3
0212   C    DET1,DET2,DET3 CONTAIN U -STATISTIC FOR H1,H2,H3 HYPOTH
```

```
0213          J1=R-1
0214          J2=C-1
0215          J3=J1*J2
0216          K=R*C*(N-1)
0217    C     DFARE P,J(I),K
0218          WRITE(IUNIT,409) DET1,P,J1,K,DET2,P,J2,K,DET3,P,J3,K
0219    409   FORMAT(//,10X,"HYPOTHESIS TEST RESULTS",//,5X,"HYPOTHESIS OF ",
0220          $10X,"U-STATISTIC",10X,"DEGREES OF FREEDOM",//,5X,
0221          1"INTERACTION EFFECT ",5X,D16.11,5X,3I7,/,5X,"FACTOR A EFFECT",
0222          28X,D16.11,5X,3I7,/,5X,"FACTOR B EFFECT",8X,D16.11,5X,3I7)
0223    C     PLACE FPROB HERE IN WANTED
0224          END
0225          SUBROUTINE ENDIO
0226    C     SUB. TO WAIT UNTIL TAPE IS FREE
0227    10    CALL EXEC(13,108,I1,I2,I3)
0228          IF(I1.LT.0) GO TO 10
0229          RETURN
0230          END
0231          SUBROUTINE INIT(RIJ)
0232          DOUBLE PRECISION RIJ(30,30)
0233          DO 10 I=1,30
0234          DO 10 J=1,30
0235    10    RIJ(I,J)=0.D0
0236          RETURN
0237          END
0238          END$
```

D. Regression and Factor Analysis

SREGR   (Simple Linear Regression)

Purpose:

> This program performs a simple linear regression, and provides
> an ANOVA goodness of fit which tests the aptness of the model.

Mathematical Model:

> The model for the regression analysis is:

$$Y_i = b_0 + b_i x_i$$

> where:

> $i = 1$ to N, the number of observations

User Considerations and Procedures:

1. Program expects a data file to be created (see DA30) with N
   records. Each record has two variables, X and Y, which are
   arranged in that order.

2. The data analysis can either be displayed on the CRT or a hard-
   copy can be obtained from the line printer. Option: 1 for CRT
   output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw
   data printout is desired, 0 for no printout. The output device
   is designated by the above option (#2).

4. Parameters required:

   a. number of observations (maximum 32767)

   b. name of data file

   c. format of data file

5. Printout gives:

   a. raw data (optional)

   b. $\overline{X}$ and $\overline{Y}$

   c. estimated value of B_0 and B_1

   d. ANOVA source table

   e. R value

   f. standard error of B_0 and B_1

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Test Data:

    This program was tested using data from John Neter and William Wasserman, Applied Linear Statistical Models: Regression, Analysis of Variance, and Experimental Design, Richard D. Irwin, Inc., 1974, P. 93. The program uses double precision.

```
RU,SREGR
SIMPLE REGRESSION, Y=BØ  +  B1*X
DATA ENTER AS X THEN Y
ENTER NAME OF FILE FROM DA3Ø
#SREGR
ENTER FORMAT OF DATA
(2(3X,F5.1))
ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER Ø
1
ENTER 1 FOR CRT DISPLAY, 6 FOR LINEPRINTER
6
ENTER IN NUMBER OF OBSERVATIONS
1Ø
:
```

RAW DATA

X	Y
30.0	73.0
20.0	50.0
60.0	128.0
80.0	170.0
40.0	87.0
50.0	108.0
60.0	135.0
30.0	69.0
70.0	148.0
60.0	132.0

BAR. = 50.0000   YBAR = 110.0000

B0 = 10.00000000
B1 = 2.00000000

SOURCE	SS	DF	MS	F	P(F)
MODEL	13600.0000	1	13600.0000	1813.3333	.000003
ERROR	60.0000	8	7.5000		
TOTAL	13660.0000	9			

R = .997801
STANDARD ERROR OF B0 = 2.50294
STANDARD ERROR OF B1 = .14852

```
0001    FTN4
0002           PROGRAM SREGR
0003           REAL MSE,MSR
0004           DOUBLE PRECISION X,Y,SUMX,SUMY,SUMX2,SUMY2,SUMXY,R,BO,
0005          &B1,DEN,XN,SX,SY,SXY,SSTO,SSE,MSE,MSR,SBO,SB1
0006           DIMENSION IB(144),IBUF(128),NAME(3),IFMT(20)
0007           WRITE(1,10)
0008     10    FORMAT("SIMPLE REGRESSION, Y=BO + B1*X")
0009           WRITE(1,11)
0010     11    FORMAT("ENTER NAME OF FILE FROM DA30")
0011           READ(1,12) NAME
0012     12    FORMAT(3A2)
0013           WRITE(1,13)
0014     13    FORMAT("ENTER FORMAT OF DATA")
0015           READ(1,14) IFMT
0016     14    FORMAT(20A2)
0017           CALL OPEN(IB,IER,NAME,3,0,-2,128)
0018           IF(IER.GE.0) GO TO 20
0019           WRITE(1,15) NAME,IER
0020     15    FORMAT(3A2,"FAILED TO OPEN , IER = ",I5)
0021           STOP 15
0022     20    WRITE(1,16)
0023     16    FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA,ELSE ENTER 0")
0024           READ(1,*) IPTO
0025           WRITE(1,18)
0026     18    FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR LINEPRINTER")
0027           READ(1,*) IUNIT
0028           WRITE(1,17)
0029     17    FORMAT("ENTER IN NUMBER OF OBSERVATIONS")
0030           READ(1,*) N
0031           IF(IPTO.EQ.1) WRITE(IUNIT,99)
0032     99    FORMAT(" RAW DATA "/,"        X           Y        "/)
0033           DO 30 I=1,N
0034           CALL READF(IB IER,IBUF)
0035           CALL CODE
0036           READ(IBUF,IFMT) X,Y
0037           IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) X,Y
0038           SUMX=SUMX+X
0039           SUMY=SUMY+Y
0040           SUMX2=SUMX2+X*X
0041           SUMY2=SUMY2+Y*Y
0042     30    SUMXY=SUMXY+X*Y
0043           XN=N
0044           DEN=XN*SUMX2-SUMX*SUMX
0045           BO=(SUMY*SUMX2-SUMX*SUMXY)/DEN
0046           B1=(XN*SUMXY-SUMX*SUMY)/DEN
0047           XBAR=SUMX/XN
0048           YBAR=SUMY/XN
```

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```
0049          SXY=SUMXY-SUMX*SUMY/XN
0050          SX=SUMX2-SUMX*SUMX/XN
0051          SY=SUMY2-SUMY*SUMY/XN
0052          R=SXY/DSQRT(SX*SY)
0053          R=SXY/DSQRT(SX*SY)
0054          SSTO=SUMY2-XN*YBAR*YBAR
0055          SSE=SUMY2-B0*SUMY-B1*SUMXY
0056          MSR=SSTO-SSE
0057          MSE=SSE/(XN-2.)
0058          F=MSR/MSE
0059          DF1=1
0060          DF2=N-2
0061          CALL FPROB(F,DF1,DF2,Z,P)
0062          SB0=DSQRT(MSE*(1./XN+XBAR*XBAR/SX))
0063          SB1=DSQRT(MSE/SX*XN)
0064          WRITE(IUNIT,190) XBAR,YBAR
0065    190   FORMAT(//,"XBAR = ",F10.4,"   YBAR = ",F10.4,//)
0066          WRITE(IUNIT,908) B0,B1
0067    908   FORMAT(" B0 = ",F14.8,/," B1 = ",F14.8/)
0068          WRITE(IUNIT,100)
0069    100   FORMAT(//"SOURCE",8X,"SS",10X,"DF",10X,"MS",10X,"F",10X,
0070          C"P(F)"/)
0071          DF3=DF1+DF2
0072          SSR=MSR
0073          WRITE(IUNIT,110) SSR,DF1,MSR,F,P,SSE,DF2,MSE,SSTO,DF3
0074    110   FORMAT(" MODEL",5X,F10.4,3X,F5.0,2(3X,F10.4),3X,F10.6,/" ERROR"
0075          $,5X,F10.4,3X,F5.0,3X,F10.4,/" TOTAL",5X,F10.4,3X,F5.0)
0076          WRITE(IUNIT,120) R,SB0,SB1
0077    120   FORMAT(//," R= ",F10.6,/" STANDARD ERROR OF B0 = ",F10.5,/,
0078          $" STANDARD ERROR OF B1 = ",F10.5)
0079          CALL CLOSE(I8)
0080          END
0081          END$
```

SRM30   (Correlation Matrix)

Purpose:

This program creates a correlation matrix from raw data. The matrix
is required for the factor analysis (FATAA) and multiple regression
(MRMAIN) programs.

User Considerations and Procedures:

1. A matrix data file must be created with n point per record.

2. The data analysis can either be displayed on the CRT or a hard-
    copy can be obtained from the line printer. Option: 1 for CRT
    output, 6 for line printer output.

3. The correlation matrix can be saved in the file SRDATA. This
    matrix is necessary for FATAA and/or MRMAIN. To save this matrix,
    enter 1 for yes, 0 for no.

4. Parameters required:

    a. number of variables (maximum 30)

    b. name, format, and record length of data file (see 0A30)

    c. number of subjects (maximum 32767)

    d. names of the n variables (maximum 8 characters per name, one
        name per line)

    e. scratch file name - do not use the same SCRTCH. This file
        is a working file and is destroyed upon completion of SRM30.

    f. number of variables per line for output

5. Printout gives:

    a. number of variables

    b. number of subjects

    c. two-tailed significance level

    d. $\overline{X}$, SD, name of each variable

    e. correlation matrix

Comments:

Whenever the option to save the correlation matrix is specified, the previous content in the SRDATA file is destroyed. Therefore, FATAA and/or MRMAIN should be run before using SRM30 again in order to preserve the data files. If this cannot be done, save the contents of SRDATA in another file. It will be necessary to dump the preserved data file into SRDATA before FATAA and/or MRMAIN analyses are done.

Test Data:

This program was tested using data presented on the next page. The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to six digit places instead of ten digits.

Subject	1	2	3	4	5	6	7	8
0001	24.00	81.00	992.00	1024.0	978.00	1101.0	936.00	1120.0
0002	25.00	22.00	181.00	310.00	293.00	346.00	188.00	166.00
0003	27.00	57.00	124.00	172.00	166.00	491.00	154.00	83.00
0004	29.00	36.00	553.00	719.00	605.00	833.00	585.00	346.00
0005	30.00	54.00	1046.0	2221.0	1841.0	2656.0	1062.0	1030.0
0006	31.00	25.00	322.00	522.00	402.00	676.00	261.00	379.00
0007	32.00	78.00	839.00	364.00	222.00	433.00	1014.0	584.00
0008	35.00	80.00	575.00	405.00	456.00	320.00	789.00	320.00
0009	36.00	30.00	835.00	811.00	716.00	824.00	735.00	975.00
0010	37.00	80.00	1001.0	166.00	179.00	154.00	907.00	1065.0
0011	37.00	57.00	1418.0	1706.0	1656.0	1759.0	1024.0	219.00
0012	45.00	74.00	531.00	503.00	581.00	593.00	481.00	593.00
0013	77.00	66.00	218.00	637.00	681.00	591.00	300.00	201.00
0014	80.00	47.00	133.00	109.00	112.00	106.00	166.00	108.00
0015	80.00	80.00	74.00	100.00	115.00	90.00	79.00	68.00
0016	80.00	74.00	550.00	322.00	422.00	204.00	600.00	400.00
0017	18.00	61.00	72.00	429.00	456.00	411.00	405.00	856.00
0018	19.00	18.00	67.00	760.00	856.00	509.00	966.00	3216.0
0019	20.00	80.00	173.00	434.00	311.00	511.00	103.00	139.00
0020	20.00	15.00	209.00	422.00	573.00	250.00	230.00	110.00
0021	22.00	29.00	18.00	1024.0	1114.0	853.00	687.00	671.00
0022	22.00	56.00	98.00	267.00	229.00	341.00	206.00	106.00
0023	22.00	7.00	21.00	752.00	795.00	491.00	1252.0	1308.0
0024	24.00	14.00	292.00	1312.0	1324.0	1296.0	1342.0	1851.0
0025	80.00	51.00	116.00	777.00	1034.0	548.00	880.00	952.00
0026	74.00	51.00	13.00	392.00	390.00	394.00	243.00	265.00
0027	64.00	46.00	19.00	318.00	292.00	348.00	156.00	134.00
0028	60.00	37.00	42.00	703.00	787.00	578.00	142.00	257.00
0029	59.00	18.00	345.00	899.00	778.00	1141.0	424.00	411.00
0030	54.00	14.00	49.00	968.00	747.00	1521.0	925.00	857.00
0031	54.00	71.00	16.00	503.00	421.00	964.00	275.00	226.00
0032	51.00	53.00	15.00	198.00	201.00	193.00	591.00	236.00
0033								
0034								

Variables

```
 RU,SRM30
SRMAIN30
ENTER # DATA VARIABLES:
8
ENTER INPUT FILE NAME:
#FATAA
ENTER INPUT DATA FORMAT (SUBJ DATA ACROSS):
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA30
64
ENTER # SS:
32
DESIRE TO SAVE OUTPUT FOR MR?   (1=YES, 0=NO):
1
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
ENTER VARIABLE NAMES (MAX 8 CHARACTERS EACH):
A
B
C
D
E
F
G
H
ENTER NAME OF SCRATCH FILE.
IF YOU ARE CONSIDERING NAMING YOUR SCRATCH FILE 'SCRATCH'
 PLEASE NOTE THAT THE PRINCIPAL FACTORS PROGRAM FATAA
 ESTABLISHES A FILE WITH SUCH A NAME FOR USE IN THAT PARTI-
 CULAR PROGRAM.   IN ORDER TO SAVE YOURSELF SOME TIME OR TO
 AVOID ERRORS (IF YOU INTEND TO USE FATAA) IT IS TO YOUR
 BENEFIT NOT TO NAME THIS FILE 'SCRATCH.'
 SCRATCH FILE NAME =
HELLO

ENTER # VBS. PER PAGE FOR OUTPUT:
8


SRM30 IS NOW FINISHED
:
```

```
NUMBER OF VARIABLES  =  8
NUMBER OF SUBJECTS   = 32

TWO-TAILED SIGNIFICANCE LEVELS
P = .050     P = .010     P = .005     P = .001
 .29635        .35203       .46338        .59090


VB       MEAN              SD
 1      42.750           21.350        A
 2      48.812           23.575        B
 3     342.375          374.970        C
 4     632.781          457.059        D
 5     616.656          422.742        E
 6     672.687          534.885        F
 7     565.875          370.204        G
 8     601.625          636.181        H
```

	1	2	3	4	5	6	7	8
1	1.0000	.2301	-.2057	-.2388	- 2014	-.2070	-.3045	-.3451
2	.2301	1.0000	.3379	-.2689	-.2920	-.1948	-.1690	-.3307
3	-.2057	.3379	1.0000	.4819	-.2920	-.1948	-.1690	-.3307
4	-.2388	-.2689	.4819	1.0000	.9689	.9375	.4920	.0846
5	-.2014	-.2920	.4241	.9689	1.0000	.8408	.6105	.3755
6	-.2070	-.1948	.4659	.9375	.8408	1.0000	.6300	.4281
7	-.3045	-.1690	.4920	.9375	.8408	1.0000	.4869	.2326
8	-.3451	-.3307	.0846	.6105	.6300	.4869	1.0000	.6872

```
0001  FTN4
0002        PROGRAM SRM30
0003        INTEGER XNAME
0004        DOUBLE PRECISION XBAR(30),SIG(3^),R(30,60),X(30)
0005        DOUBLE PRECISION VAR
0006        DIMENSION IB(272),IC(272),ID(272),IDUF(256)
0007        DIMENSION ISIZE(2),IA(3),NAMA(3),NAMB(3)
0008        DIMENSION XNAME(<0,4),INFILE(3),IFMT(20),ISCTCH(3)
0009        COMMON XBAR,SIG,R,X,VAR
0010        DATA IA/2HSR,2HDA,2HTA/
0011        DATA NAMA/2HMR,2HM3,1HO/
0012        DATA NAMB/2HFA,2HTA,1HA/
0013        WRITE(1,4400)
0014  4400  FORMAT ( "&SRMAIN30"  )
0015        WRITE(1,4401)
0016  4401  FORMAT ( "&ENTER # DATA VARIABLES: ")
0017        READ(1,*)  L
0018        WRITE(1,4402)
0019  4402  FORMAT ( "&ENTER INPUT FILE NAME:"  )
0020        READ(1,2)INFILE
0021  2     FORMAT(3A2)
0022        WRITE(1,4406)
0023  4406  FORMAT ( "&ENTER INPUT DATA FORMAT (SUBJ DATA ACROSS):" )
0024        READ(1,231)IFMT
0025  231   FORMAT(20A2)
0026        WRITE(1,88)
0027  88    FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0028        READ(1,*)LENGTH
0029        LEN=LENGTH/2
0030        IF((LEN*2).NE.LENGTH) LEN=LEN+1
0031        LENGTH=LEN
0032        IDCBS=LENGTH
0033        IF(LENGTH.LT.144) IDCBS=144
0034        WRITE(1,4403)
0035  4403  FORMAT ( "&ENTER # SS: ")
0036        READ(1,*)  KNT
0037        WRITE(1,4404)
0038  4404  FORMAT ( "&DESIRE TO SAVE OUTPUT FOR MR? (1=YES; 0=NO):  ")
0039        READ(1,*) NPCH
0040  25    WRITE(1,4405)
0041  4405  FORMAT ( "&ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
0042        READ(1,*) IUNIT
0043        IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 25
0044        IF(NPCH.LE.0)GO TO 27
0045  27    CALL OPEN(IB,IER,INFILE,3,0,-2,IDCBS)
0046        IF(IER.GE.0) GO TO 800
0047        WRITE(1,801) INFILE,IER
0048  801   FORMAT(" NO OPEN DATA FILE ",3A2,"   IER = ",I5)
0049        STOP 701
```

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```
0050   800     DO 5 K=1,30
0051           XBAR(K)=0
0052           SIG(K)=0
0053           DO 275 I=1,4
0054   275     XNAME(K,I)=0
0055           DO 5 J=1,60
0056   5       R(K,J)=0
0057           WRITE(1,4407)
0058   4407    FORMAT ( "$ENTER VARIABLE NAMES (MAX 8 CHARACTERS EACH): "  )
0059           DO 19 I=1,L
0060           READ(1,4)(XNAME(I,J),J=1,4)
0061   4       FORMAT(4A2)
0062   19      CONTINUE
0063           NS=0
0064           WRITE(1,4408)
0065   4408    FORMAT ( "$ENTER NAME OF SCRATCH FILE." )
0066           WRITE(1,4409)
0067   4409    FORMAT ("IF YOU ARE CONSIDERING NAMING YOUR SCRATCH FILE",
0068          1" 'SCRATCH ")
0069           WRITE(1,4410)
0070   4410    FORMAT("PLEASE NOTE THAT THE PRINCIPAL FACTORS PROGRAM FATAA")
0071           WRITE(1,4411)
0072   4411    FORMAT ( " ESTABLISHES A FILE WITH SUCH A NAME FOR USE",
0073          2"IN THAT PAR-")
0074           WRITE(1,4412)
0075   4412    FORMAT(" TICULAR PROGRAM. IN ORDER TO SAVE YOURSELF SOME TIME")
0076           WRITE(1,4413)
0077   4413    FORMAT (" OR TO AVOID ERRORS (IF YOU INTEND TO USE FATAA) IT")
0078           WRITE(1,4414)
0079   4414    FORMAT(" IS TO YOUR BENEFIT NOT TO NAME THIS FILE 'SCRATCH'.")
0080           WRITE(1,4415)
0081   4415    FORMAT ( " SCRATCH FILE NAME=  "  )
0082           READ(1,2)ISCTCH
0083           ISIZE(2)=LENGTH
0084           XSU=KNT
0085           SIZE=LENGTH
0086           SIZE=XSU*SIZE/128. + 1.
0087           ISIZE(1)=SIZE
0088           CALL CREAT(IC,IER,ISCTCH,ISIZE,2,0,-2,IDCBS)
0089           IF(IER.GE.0) GO TO 810
0090           WRITE(1,809) ISCTCH,IER
0091   809     FORMAT(" NO OPEN SCRATCH FILE ",3A2," IER = ",I5)
0092           CALL CLOSE(IB)
0093           STOP 702
0094   810     DO 11 JM=1,KNT
0095           CALL READF(IB,IER,IDUF)
0096           CALL CODE
0097           READ(IDUF,IFMT)(X(I),I=1,L)
0098           NS=NS+1
0099           DO 7 J=1,L
0100   7       XBAR(J)=XBAR(J)+X(J)
0101           CALL CODE
0102           WRITE(IDUF,IFMT)(X(J),J=1,L)
0103           CALL WRITF(IC,IER,IDUF)
0104   11      CONTINUE
0105           CALL CLOSE(IC)
0106           DO 9 J=1,L
```

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```
0107   9      XBAR(J)=XBAR(J)/NS
0108          CALL OPEN(IC,IER1,ISCTCH,3,0,-2,IDCBS)
0109          IF(IER1.GE.0) GO TO 820
0110          WRITE(1,801) ISCTCH,IER1
0111   .      CALL CLOSE(IB)
0112          STOP 703
0113   820    DO 1400 JM=1,NS
0114          CALL READF(IC,IER,IDUF)
0115          CALL CODE
0116          READ(IDUF,IFMT)(X(J),J=1,L)
0117          DO 1400 J=1,L
0118          DO 1400 K=1,L
0119   1400   R(J,K)=R(J,K)+(X(J)-XBAR(J))*(X(K)-XBAR(K))
0120          CALL CLOSE(IC)
0121          DO 1401 J=1,L
0122          VAR=R(J,J)/NS
0123          IF(VAR.EQ.0.0)GO TO 1408
0124          SIG(J)=DSQRT(VAR)
0125          GO TO 1401
0126   1408   SIG(J)=0.0
0127   1401   CONTINUE
0128          DO 1402 J=1,L
0129          DO 1402 K=J,L
0130          R(J,K)=R(J,K)/NS
0131          IF(SIG(J)*SIG(K).NE.0.0)GO TO 1406
0132          R(J,K)=0
0133          GO TO 1407
0134   1406   R(J,K)=R(J,K)/(SIG(J)*SIG(K))
0135   1407   R(K,J)=R(J,K)
0136   1402   CONTINUE
0137          WRITE(IUNIT,98)L,NS
0138   98     FORMAT(" NUMBER OF VARIABLES = ",I3/
0139          $" NUMBER OF SUBJECTS = ",I5)
0140          SS=NS
0141          SE=1./SQRT(SS-1)
0142          SA=1.65*SE
0143          SB=1.96*SE
0144          SC=2.58*SE
0145          SD=3.29*SE
0146          IF(NPCH.LE.0)GO TO 91
0147          CALL OPEN(ID,IER,IA,3,0,-2,256)
0148          IF(IER.GE.0) GO TO 840
0149          WRITE(1,801) IA,IER
0150          CALL CLOSE(IB)
0151          CALL CLOSE(IC)
0152          STOP 740
0153   840    DO 802 J2=1,60
0154          CALL CODE
0155          WRITE(IDUF,94)(R(J1,J2),J1=1,30)
0156   94     FORMAT(30(2X,F10.4))
0157          CALL WRITF(ID,IER,IDUF)
0158   802    CONTINUE
0159          CALL CODE
0160          WRITE(IDUF,94) XBAR
0161          CALL WRITF(ID,IER,IDUF)
0162          CALL CODE
```

```
0163          WRITE(IDUF,94) SIG
0164          CALL WRITF(ID,IER,IDUF)
0165          CALL CODE
0166          WRITE(IDUF,808) ((XNAME(I1,I2),I2=1,4),I1=1,30)
0167          CALL WRITF(ID,IER,IDUF)
0168    808   FORMAT(30(4X,4A2))
0169    91    WRITE(IUNIT,13)
0170    13    FORMAT(/"            VB.     MEAN        SD")
0171          DO 14 I=1,L
0172    14    WRITE(IUNIT,15)I,XBAR(I),SIG(I),(XNAME(I,J),J=1,4)
0173    15    FORMAT(9X,I3,2F10.3,10X,4A2)
0174    100   WRITE(1,4416)
0175    4416  FORMAT (  " " )
0176    101   WRITE(1,4417)
0177    4417  FORMAT (  "&ENTER # VBS. PER PAGE FOR OUTPUT:  ")
0178          READ(1,*) NPAGE
0179          IF(NPAGE.GT.L)GO TO 101
0180          NPX=NPAGE-1
0181          KM=((L-1)/NPAGE+1)*NPAGE
0182          DO 995 M=NPAGE,KM,NPAGE
0183          LA=M-NPX
0184          IF(M-KM)997,996,997
0185    996   M=L
0186    997   WRITE(IUNIT,910)(I,I=LA,M)
0187    910   FORMAT(/7X,10(I10,1X))
0188          DO 995 I=1,L
0189    995   WRITE(IUNIT,930)I,(R(I,J),J=LA,M)
0190    930   FORMAT(I5,F13.4,1X,9(F10.4,1X))
0191    931   WRITE(1,4418)
0192    4418  FORMAT(///,"SRM30 IS NOW FINISHED")
0193          CALL CLOSE(IB)
0194          CALL CLOSE(IC)
0195          CALL CLOSE(ID)
0196          CALL PURGE(ID,IER,ISCTCH)
0197          STOP
0198          END
0199          END$
```

MRMAIN   (Multiple Regression Analysis)

Purpose:

This program performs a multiple regression analysis, arriving at
a final equation using a forward stepwise procedure based on a
maximum R-squared and F-test criteria.

Mathematical Model:

The model for the regression analysis is:

$$Y_i = B_0 + B_1 X_{1i} + B_2 X_{2i} + \ldots B_j X_{ji} + E_i$$

where:

Y_i = ith observation of dependent variables

X_{ji} = ith observation of the jth independent variable

B_j = regression coefficient

E_i = normally distributed error term

User Considerations and Procedures:

1. Program requires input from SRM30. MRMAIN reads the file
    SRDATA created by SRM30 to receive the correlation matrix,
    variable means, standard deviation, and variable names.

2. Initial options and parameters:

    a. option for device output; enter 6 for line printer or
        1 for CRT

    b. enter number of variables from SRM30 (maximum 30)

    c. enter the number of subjects on which correlation matrix
        is based

    d. enter number of the dependent variable (as entered in SRM30)

    e. enter minimum acceptable F for inclusion in equation -
        standard or typical value is 1

    f. enter the number of va   bles excluded from model, and those
        forced in model. If none are excluded, enter 0. If none
        are forced, enter 0

1) if the number excluded is not 0, program asks which
   variables are to be excluded. Enter the variable
   numbers of those to be excluded. These can be entered
   in any order separated by commas.
2) If the number forced is not 0, program asks how the vari-
   ables are to be forced in the equation. Enter the variable
   numbers of the forced variables in the order they are to
   be forced. Separate the varables numbers by commas. (NOTE:
   forcing variables that are highly correlated to each other
   will cause stability problems.)

g.   enter number of this equation - enter 1, usually

h.   enter number of additional composites desired

i.   in the following options, enter 1 for yes, 0 for no:

1) suppress weight reversals (0 forces $B_j \geqslant 0$)
2) multiply weights by 1000
3) set mean of predicted scores - if 1, program then asks you
   to enter the mean
4) set standard deviation of predicted score - if 1, program
   asks you to enter the standard deviation
5) check parameters, enter 1 if they are correct or 0 to restart

2. Options for storing data in order to plot the residuals: Enter
    1 to plot residuals, 0 otherwise. (NOTE: If 1 is entered a
    scratch tape must be mounted. Residuals are outputted to mag-
    netic tape as Y-criterion, Y-predicted in a (2(5X,F10.3)) format.
    To plot residuals run the program RESID. When this option is
    used, the name of raw data file and format of file is required.)

3. Printout gives:

    a. copy of desired initial options and parameters

    b. listing of variable names and corresponding $\overline{X}$, and standard
        deviation

    c. as each variable is entered into the model the following
        information is given: number entered, variable numbers,
        cumulative multiple R, cumulative multiple R increase by
        this variable, R-square, shrunken R-squared, F-value for
        entering into model, degrees of freedom and probability
        of the F-value, and name of variable entered

d. after each vairable is entered, the following information is given: the number entered, the variable number, mean, standard deviation, Z-weight, raw score weight (B_j), critical R, Z-weight * critical R, and variable name

e. B_0 or constant is printed out for each step

Comments:

The scratch file is automatically purged from the disc at end of the MRMAIN run.

Test Data:

This program was tested using data presented below. The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to five or six digit places instead of ten digits except when variables are forced into the model that are too highly correlated, (i.e., > .99). In those cases accuracy is less than five digit places.

Subject	Independent Variable	Dependent Variable		
		1	2	3
1	19	1	1	1
2	28	2	2	2
3	17	1	-1	5
4	42	3	4	5
5	24	1	2	3
6	1	-1	-1	-1
7	8	-1	2	3
8	16	0	3	-3

```
 RU,MRMAIN
:SV,4
MRMAIN30
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:
6
ENTER # VBS IN MATRIX (MAX 30):
4
ENTER # SS ON WHICH CORRELS BASED:
8
ENTER # OF CRIT VARIABLE:
1
ENTER MINIMUM ACCEPTABLE F FOR INCLUSION IN EQUATION:
1
ENTER # VBS EXCLUDED, & # VBS FORCED·
0,0
ENTER # OF THIS EQUATION:
1
ENTER # OF ADDITIONAL COMPOSITES DESIRED:
0
IN THE FOLLOWING DIALOG, 1 = YES, 0 = NO
SUPPRESS WT REVERSALS?
1
MULT WTS BY 1000?
0
SET MEAN OF PREDICTED  CORES?
0
SET SD OF PREDICTED SCORES?
0
SUPPRESS ADDITIONAL SHRUNKEN R ESTIMATES?
0
CHECK ABOVE PARAMETERS, ENTER 1 TO CONTINUE, 0 TO RESTART:
1
ENTER NAME OF SCRATCH FILE:
TECH 1
ENTER 1 TO PLOT RESIDUALS (Y-PRED VS Y-OBS):
1
 OUTPUT FILE FOR RESIDUALS IS MAG TAPE!
ENTER RAW DATA FILE NAME:
#MRM30
ENTER RAW DATA FORMAT:
(4(4X,F10.4))
MRM30 FINISHED
MRM30 ABORTED
```

VBS = 4
SS   = 8
F-VALUE = 1
WT. REVERSALS SUPPRESSED.
INPUT FILE: SRDATA
SCRATCH FILE: TECH1

VB.	MEAN	ST. DEV.	
1	19.375	11.683	Y
2	.750	1.299	X
3	1.500	1.658	F
4	1.875	2.619	G

CRIT VB 1) Y   MEAN: 19.375; SIGMA: 11.683

VARIABLE ADDED: 2) (CRIT. IS NO. 1 Y   ).

N.	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1&	PROB(F)
1	2	.961600	.961600	.924675	.955050	73.6543	6	.00039

CORRECTED SHRUNKEN R ESTIMATES: .943   .939; CUM ERROR PROB: .000388

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R	
1	2	.750	1.299	.96160	8.64825	.96160	.92467	X

CONSTANT: 12.889

VARIABLE ADDED: 3)(CRIT. IS NO. 1 Y   )

N	VB.	CUM MULT R	INCREASE	R-SQUARE	SHRNKN R	F-VALUE	DF=1&	PROB(F)
2	3	.995407	.033807	.990835	.993564	36.0956	5	.00256

CORRECTED SHRUNKEN R ESTIMATES: .992   .989; CUM ERROR PROB: .002946

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R	
1	2	.750	1.299	.82680	7.43588	.96160	.79505	X
2	3	1.500	1.658	.29040	2.04587	.67420	.19579	F

CONSTANT: 10.729

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VARIABLE ADDED: 4)(CRIT. IS NO. 1 Y).
N VB. CUM MULT R INCREASE R-SQUARE SHRNKN R F-VALUE DF=1 & PROB(F)
3 4 .997799 .002392 .995603 .996145 4.3379 4 .10515

CORRECTED SHRUNKEN R ESTIMATES: .995 .991; UM ERROR PROB: .107785

FINAL EQUATION:

N	VB.	MEAN	SIGMA	Z-WEIGHT	RAW SCR WT	CRIT R	Z-WT*CRIT R	
1	2	.750	1.299	.76987	6.92390	.96160	.74031	X
2	3	1.500	1.658	.31313	2.20600	.67420	.21111	F
3	4	1.875	2.619	.08558	.38175	.51630	.04419	G

CONSTANT: 10.157

INPUT RAW DATA FILE: #MRM30
INPUT DATA FORMAT: (4(4X,F10.4))
RESIDUALS OUTPUT TO TAPE:
(CRITERION, Y-PREDICTED 2(5X,F10.3) FORMAT)

MRMAIN T=00004 :S ON CR00002 USING 00001 BLKS R=0005

```
0001     :SV,4
0002     :RP,MRM30
0003     :RU,MRM31
0004     :OF,MRM30
0005     :SV,1
```

```
0001   FTN4
0002          PROGRAM MRM30
0003          COMMON IUNIT,NINC,IFIN,L,N,NC,FVAL,NEX,NFRCE,NTIME,NRPT,
0004         $NPOS,MULT,ICOM,TMN,TSIG,NSMR,AL,NPASS,ICOMM,NFA
0005          COMMON IRDFIL(3),IRFMT(20),RDATA(30)
0006          INTEGER RFMT(20),XNAME
0007          COMMON ISIZE(2),INFILE(3),IFMT(20)
0008          COMMON SGN(30),KFRCE(30),WT(30),KKX(30)
0009          COMMON X(60),NX(30)
0010          COMMON R(30,60),SIG(30),XBAR(30),XNAME(30,4)
0011          COMMON IB(272),IBUF(256)
0012          DIMENSION ISRD(3)
0013          DATA ISRD/2HSR,2HDA,2HTA/
0014   1000   IF(NTIME.GT.1)GO TO 4000
0015   3000   CALL OPEN(IB,IER,ISRD,3,0,-2,256)
0016          IF(IER.GE.0) GO TO 3010
0017          WRITE(1,4420) IER
0018   4420   FORMAT ( "NO OPEN SRDATA, IER = ",I5 )
0019          STOP 4420
0020   3010   WRITE(IUNIT,3020)
0021   3020   FORMAT(" INPUT FILE: SRDATA")
0022          DO 4421 IJ=1,60
0023          CALL READF(IB,IER,IBUF)
0024          CALL CODE
0025          READ(IBUF,94) (R(JI,IJ),JI=1,30)
0026   94     FORMAT(30(2X,F10.4))
0027   4421   CONTINUE
0028          CALL READF(IB,IER,IBUF)
0029          CALL CODE
0030          READ(IBUF,94) XBAR
0031          CALL READF(IB,IER,IBUF)
0032          CALL CODE
0033          READ(IBUF,94) SIG
0034          CALL READF(IB,IER,IBUF)
0035          CALL CODE
0036          READ(IBUF,808) ((XNAME(I1,I2),I2=1,4),I1=1,30)
0037   808    FORMAT(30(4X,4A2))
0038          CALL CLOSE(IB)
0039   3150   IF(NTIME.GT.0)GO TO 4000
0040          IF(NRPT.LE.0)GO TO 4000
0041          NTIME=1
0042   4000   CONTINUE
0043          EWP=1
0044          IG1=NFRCE
0045          IG2=NFA
0046          IG3=NEX
0047          IF(NTIME.NE.1)GO TO 4080
0048          WRITE(1,4430)
0049   4430   FORMAT ( "&ENTER NAME OF SCRATCH FILE:" )
0050          READ(1,3071)INFILE
```

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```
0051          ISIZE(1)=73
0052          ISIZE(2)=150
0053          CALL CREAT(IB,IER,INFILE,ISIZE,2,0,-2,150)
0054          IF(IER.GE.0)GO TO 4030
0055          WRITE(1,4431) IER
0056    4431  FORMAT ( "NO OPEN SCRATCH FILE, IER = ",I5 )
0057          STOP 4431
0058    4030  IF(IUNIT.EQ.6)WRITE(IUNIT,4040)INFILE
0059    4040  FORMAT(" SCRATCH FILE: ",3A2)
0060          CALL CODE
0061          WRITE(IBUF,22) XBAR
0062    22    FORMAT(30F10.4)
0063          CALL WRITF(IB,IER,IBUF)
0064          CALL CODE
0065          WRITE(IBUF,22) SIG
0066          CALL WRITF(IB,IER,IBUF)
0067          DO 4070 I=1,60
0068          CALL CODE
0069          WRITE(IBUF,22) (R(J,I),J=1,30)
0070    4070  CALL WRITF(IB,IER,IBUF)
0071          CALL CLOSE(IB)
0072    4080  IF(NTIME.LT.2)GO TO 4110
0073          CALL OPEN(IB,IER,INFILE,3,0,-2,150)
0074          IF(IER.GE.0)GO TO 4090
0075          WRITE(1,4433) IER
0076    4433  FORMAT ( "NO RE-OPEN SCRATCH FILE, IER = ",I5  )
0077          STOP  4433
0078    4090  CALL READF(IB,IER,IBUF)
0079          CALL CODE
0080          READ(IBUF,22) XBAR
0081          CALL READF(IB,IER,IBUF)
0082          CALL CODE
0083          READ(IBUF,22) SIG
0084          DO 4100 I =1,60
0085          CALL READF(IB,IER,IBUF)
0086          CALL CODE
0087    4100  READ(IBUF,22) (R(J,I),J=1,30)
0088    4110  WRITE(IUNIT,4120)
0089    4120  FORMAT(//14X," VB.          MEAN          ST. DEV."//)
0090          KKM=NEX
0091          DO 4160 I=1,L
0092          SGN(I)=R(I,NC)
0093          IF(NEX.LE.0)GO TO 4140
0094          DO 4130 J=1,NEX
0095          KKX(J)=NX(J)
0096          NZ=NX(J)
0097          IF(I.EQ.NZ)GO TO 4160
0098    4130  CONTINUE
0099    4140  WRITE(IUNIT,4150)I,XBAR(I),SIG(I),(XNAME(I,J),J=1,4)
0100    4150  FORMAT(14X,I3,5X,F10.3,5X,F10.3,5X,4A2 )
0101    4160  CONTINUE
0102          IF(TMN.GT.0.)XBAR(NC)=TMN
0103          IF(TSIG.GT.0.)SIG(NC)=TSIG
0104          K=L+1
0105          NT=2*L
```

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```
0106        DO 4190 I=K,NT
0107        DO 4190 J=1,L
0108        M=J+L
0109        IF(I-M)4180,4170,4180
0110  4170  R(J,I)=-1.0
0111        GO TO 4190
0112  4180  R(J,I)=0
0113  4190  CONTINUE
0114        IF(NEX)4220,4220,42000
0115  42000 DO 4210 J=1,NEX
0116        NZ=NX(J)
0117        DO 4210 I=1,L
0118        R(NZ,I)=0.
0119  4210  R(I,NZ)=0.
0120  4220  AMA=0.
0121        OLDR=0.
0122        AN=N-1
0123        DO 4230 I=1,L
0124  4230  NX(I)=0
0125        MFR=1
0126        TS=SIG(NC)
0127        IF(MULT.LE.0)GO TO 4240
0128        IF(TSIG.GT.0.)MULT=0
0129  4240  IF(MULT.GT.0)TS=TS*1000.
0130  5000  CONTINUE
0131        WRITE(IUNIT,5020)NC,(XNAME(NC,I),I=1,4),XBAR(NC),TS
0132  5020  FORMAT("0*** CRIT VB ***",I4,"; ",4A2,"MEAN: ",F10.3,
0133       $") SIGMA: ",F10.3)
0134  5030  DO 5060 I=1,L
0135        IF(R(I,I)-.001)5040,5040,5050
0136  5040  X(I)=0.
0137        GO TO 5060
0138  5050  X(I)=-(R(I,NC)**2)/R(I,I)
0139  5060  CONTINUE
0140        X(NC)=0.
0141        IF(MFR.GT.NFRCE)GO TO 5070
0142        M=KFRCE(MFR)
0143        MFR=MFR+1
0144        TEMP=X(M)
0145        GO TO 5120
0146  5070  IF(NPOS..E.0)GO TO 5090
0147        DO 5080 I=1,L
0148        TEMP=R(I,NC)*SGN(I)
0149        IF(TEMP.LE.0.)X(I)=0.
0150  5080  CONTINUE
0151  5090  TEMP=X(1)
0152        M=1
0153        DO 5110 I=2,L
0154        IF(X(I)-TEMP)5110,5110,5100
0155  5100  TEMP=X(I)
0156        M=I
0157  5110  CONTINUE
0158  5120  AMA=AMA+1.
0159        NFA=NFA-1
0160        DFA=AN-AMA
0161        V=R(NC,NC)-TEMP
```

```
0162          IF(V-.001)5130,5130,5140
0163    5130  FRAT=1000.
0164          AMA=L
0165          GO TO 5150
0166    5140  FRAT=(TEMP*DFA)/V
0167          IF(NFA.GE.0)GO TO 5150
0168          IF(FRAT-FVAL)6050,6050,5150
0169    5150  IF(R(M,M).GT.0.001)GO TO 5160
0170          V=0.
0171          GO TO 5170
0172    5160  V=1./SQRT(R (M,M))
0173    5170  DO 5180 I=1,NT
0174    5180  X(I)=R(M,I)*V
0175          DO 5190 I=1,L
0176          IF(X(I).EQ.0.)GO TO 5190
0177          DO 5190 J=1,NT
0178          IF(X(J).EQ.0.)GO TO 5190
0179          R(I,J)=R(I,J)-X(I)*X(J)
0180    5190  CONTINUE
0181          R(M,M)=0.
0182          RMS=R(.,.,NC)
0183          RKK=RMS*(AM/DFA)
0184          RSH=1.-RKK
0185          IF(NSHR.GT.0)GO TO 52000
0186          RSS5=1.-RKK*(1.+(AL/(2.*DFA)))
0187          RSS3=1.-RKK*((AM+2.)/(AM+1.))*((AM-1.)/(DFA-1.))
0188          IF(RSS5.GT.0.)RSS5=SQRT(RSS5)
0189          IF(RSS3.GT.0.)RSS3=SQRT(RSS3)
0190    52000 IF(RSH.GT.0.)RSH=SQRT(RSH)
0191          RMS=1.-RMS
0192          RM=SQRT(RMS)
0193          UP=RM-OLDR
0194          K=AMA
0195          NDF=DFA
0196          PB=1.0
0197          CALL FPROB(FRAT,PB,DFA,ZZ,PP)
0198          PPB=1.-PP
0199          EWP=EWP*PPB
0200          EWR=1.-EWP
0201          WRITE(IUNIT,6010)M,NC,(XNAME(NC,I),I=1,4)
0202    6010  FORMAT("0VARIABLE ADDED: ",I3,"(CRIT. IS NO.",I3,2X,4A2,").")
0203          WRITE(IUNIT,6020)
0204    6020  FORMAT("    N.    VB.    CUM MULT R    INCREASE       R-SQUARE",
0205         $"      SHRNKN R      F-VALUE           DF=1 &     PROB(F)")
0206          WRITE(IUNIT,6030)K,M,RM,UP,RMS,RSH,FRAT,NDF,PP,(XNAME(M,I),
0207         CI=1,4)
0208    6030  FORMAT(" ",I3,2X,I3,4(4X,F9.6),F11.4,8X,I5,7X,F8.5,5X,4A2)
0209          NINC=NINC+1
0210          OLDR=RM
0211          NX(M)=K
0212          KKM=KKM+1
0213          KKX(KKM)=M
0214          NCK=L-K-1-NEX
0215          IF(NSHR.GT.0)GO TO 6050
0216          WRITE(IUNIT,6040)RSS5,RSS3,EWR
0217    6040  FORMAT(" "/" CORRECTED SHRUNKEN R ESTIMATES: ",2F12.3,
0218         $") CUM ERROR PROB: ",F10.6/)
```

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```
0219    6050    K=L+1
0220            DO 6060 J=K,NT
0221            M=J-L
0222    6060    WT(M)=R(HC,J)
0223            TEMP=0.
0224            NVBS=L-1-NEX
0225            IF(NFA.GE.0)GO TO 6080
0226            IF(FRAT.GT.FVAL.AND.NINC.LT.NVBS)GO TO 6080
0227    6065    WRITE(IUNIT,6070)
0228    6070    FORMAT("0      FINAL EQUATION: "/)
0229            IFIN=1
0230    6080    CONTINUE
0231            DO 6100 J=1,L
0232            IF(NX(J).LE.0)GO TO 6100
0233            V=SIG(HC)/SIG(J)
0234            IF(TSIG.GT.0.)V=V/RM
0235            X(J)=WT(J)*V
0236            IF(MULT.LE.0)GO TO 6090
0237            XKTP=X(J)*1000.+0.5
0238            KTP=XKTP
0239            X(J)=KTP
0240    6090    TEMP=TEMP+X(J)*XBAR(J)
0241    6100    CONTINUE
0242            Z=XBAR(HC)-TEMP
0243            WRITE(IUNIT,6110)
0244    6110    FORMAT("      N    VB.      MEAN        SIGMA      Z-WEIGHT",
0245            $"     RAW SCR WT     CRIT R    Z-WT*CRIT R"/)
0246            DO 6130 I=1,L
0247            PROD=SGN(I)*WT(I)
0248            IF(NX(I))6130,6130,6120
0249    6120    WRITE(IUNIT,6150)NX(I),I,XBAR(I),SIG(I),WT(I),X(I),SGN(I),PROD,
0250            $(XNAME(I,J),J=1,4)
0251    6130    CONTINUE
0252            WRITE(IUNIT,6140)Z
0253    6140    FORMAT("      CONSTANT: ",F10.3)
0254    6150    FORMAT(2X,I3,I4,4X,F10.3,3X,F10.3,3X,F9.5,F13.5,2(3X,F9.5)
0255            $5X,4A2)
0256            WRITE(IUNIT,6160)
0257    6160    FORMAT(" ")
0258    6161    GO TO 6168
0259    65432   IPL=0
0260            WRITE(1,4500)
0261    4500    FORMAT ( "ENTER 1 TO PLOT RESIDUALS (Y-PRED VS Y-OBS): ")
0262            READ(1,*)  IPL
0263            IF(IPL.EQ.0)GO TO 7000
0264            WRITE(1,4501)
0265    4501    FORMAT(" OUTPUT FILE FOR RESIDUALS IS MAG TAPE!&A")
0266    6162    WRITE(1,4503)
0267    4503    FORMAT ( "ENTER RAW DATA FILE NAME:"  )
0268            READ(1,3071)IRDFIL
0269            WRITE(1,4504)
0270    4504    FORMAT ( "ENTER RAW DATA FORMAT:" )
0271            READ(1,3070)IRFMT
0272            CALL OPEN(IB,IER,IRDFIL,3,0,-2,256)
0273            IF(IER.GE.0)GO TO 6143
0274            WRITE(1,4505) IER
0275    4505    FORMAT ( "NO OPEN RAW DATA FILE, IER = ",I5   )
0276            STOP
```

```
0277   6163    WRITE(IUNIT,61635)IRDFIL,IRFMT
0278           WRITE(IUNIT,61636)
0279   61635   FORMAT("0INPUT RAW DATA FILE: ",3A2/" INPUT DATA FORMAT:",
0280           $20A2)
0281   61636   FORMAT(" RESIDUALS OUTPUT TO TAPE: ",/" (CRITERION,"
0282           $"Y-PREDICTED 2(5X,F10.3) FORMAT)")
0283           DO 6166 I1=1,N
0284           YP=Z
0285           CALL READF(IB,IER,IBUF)
0286           CALL CODE
0287           READ(IBUF,IRFMT)(RDATA(I2),I2=1,L)
0288           DO 6164 I2=1,L
0289           IF(NX(I2).GT.0)YP=YP+X(I2)*RDATA(I2)
0290   6164    CONTINUE
0291           WRITE(8,8185)RDATA(NC),YP
0292   8185    FORMAT(2(5X,F10.3))
0293   6166    CONTINUE
0294   6167    CALL CLOSE(IB)
0295           ENDFILE 8
0296           GO TO 7000
0297   6168    IFIN=0
0298           IF(NCK.LE.0)GO TO 6170
0299           IF(FRAT.GT.FVAL)GO TO 5030
0300           IF(NFA.GE.0)GO TO 5030
0301   6170    IF(NRPT.LE.0)GO TO 62000
0302           NPASS=NPASS+1
0303           IF(KKM.LE.0) GO TO 5647
0304           DO   6180 I=1,KKM
0305   6180    NX(I)=KKX(I)
0306   5647    NINC=0
0307           NTIME=2
0308           KKM=IG3
0309           NFRCE=IG1
0310           NFA=IG2
0311           WRITE(IUNIT,6190)NPASS
0312   6190    FORMAT("1 EQUATION SET: ",I3," ATTEMPTED")
0313           NRPT=NRPT-1
0314           GO TO 4000
0315   62000   CONTINUE
0316           GO TO 65432
0317   7000    WRITE(1,4500)
0318   4500    FORMAT("MRM30 FINISHED &&&")
0319           CALL CLOSE(IB)
0320           CALL PURGE(IB,IER,INFILE)
0321           RLWIND 8
0322   3071    FORMAT(3A2)
0323   3070    FORMAT(20A2)
0324           STOP 1234
0325           END
0326           END$
```

```
0001    FTN4
0002          PROGRAM MRM31
0003          COMMON IUNIT,NINC,IFIN,L,N,NC,FVAL,NEX,NFRCE,NTIME,NRPT,
0004        $NPOS,MULT,ICCM,TMN,TSIG,NSMR,AL,NPASS,ICOMM,NFA
0005          COMMON IRDFIL(3),IRFMT(20),RDATA(30)
0006          INTEGER RFMT(20),XNAME
0007          COMMON ISIZE(2),INFILE(3),IFMT(20)
0008          COMMON SGN(30),KFRCE(30),WT(30),KKX(30)
0009          COMMON X(60),NX(30)
0010          COMMON R(30,60),SIG(30),XBAR(30),XNAME(30,4)
0011          COMMON IB(272),IBUF(256)
0012          DIMENSION ISRD(3),NAM1(3)
0013          DATA ISRD/2HSR,2HDA,2HTA/
0014          DATA NAM1 /2HMR,2HM3,2HO /
0015          WRITE(1,4400)
0016    4400  FORMAT ( "KRMAIN30&"   )
0017    100C  DO 1010 I=1,30
0018          SGN(I)=0
0019          KFRCE(I)=0
0020          WT(I)=0
0021          KKX(I)=0
0022          SIG(I)=0
0023          RDATA(I)=0.
0024          XBAR(I)=0
0025          NX(I)=0
0026          DO 1010 J=1,20
0027          RFMT(J)=2H
0028          IFMT(J)=2H
0029          DO 1010 K=1,60
0030          R(I,K)=0
0031          X(K)=0
0032    1010  CONTINUE
0033    900   WRITE(1,4401)
0034    4401  FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT:  ")
0035          READ(1,*) IUNIT
0036          IF(IUNIT.NE.1.AND.IUNIT.NE.6)GO TO 900
0037          NINC=0
0038          IFIN=0
0039          WRITE(1,4402)
0040    4402  FORMAT ( "&ENTER # VBS IN MATRIX (MAX 30): ")
0041          READ(1,*)  L
0042          WRITE(1,4403)
0043    4403  FORMAT ( "&ENTER # SS ON WHICH CORRELS BASED:  ")
0044          READ(1,*) N
0045          WRITE(1,4404)
0046    4404  FORMAT ( "&ENTER # OF CRIT VARIABLE: ")
0047          READ(1,*)  NC
0048          WRITE(1,4405)
0049    4405  FORMAT("&ENTER MINIMUM ACCEPTABLE F FOR INCLUSION",
0050          C" IN EQUATION. ")
```

```
0051          READ(1,*)  FVAL
0052          WRITE(1,4406)
0053   4406   FORMAT ( "&ENTER # VBS EXCLUDED, & # VBS FORCED: ")
0054          READ(1,*)  NEX,NFRCE
0055          IF(NEX.GT.0) WRITE(1,543)
0056   543    FORMAT(" ENTER ##'S OF VBS. TO EXCLUDE (ANY ORDER): ")
0057          IF(NEX.GT.0) READ(1,*) (MX(I),I=1,NEX)
0058          IF(NFRCE.GT.0) WRITE(1,544)
0059   544    FORMAT("&ENTER #'S OF VBS. TO FORCE (IN DESIRED ORDER):")
0060          IF(NFRCE.GT.0) READ(1,*) (KFRCE(I),I=1,NFRCE)
0061          WRITE(1,4407)
0062   4407   FORMAT ( "&ENTER # OF THIS EQUATION: ")
0063          READ(1,*)  NTIME
0064          WRITE(1,4408)
0065   4408   FORMAT ( "&ENTER # OF ADDITIONAL COMPOSITES DESIRED: ")
0066          READ(1,*)  NRPT
0067          NPOS=0
0068          MULT=0
0069          ICOM=0
0070          TMN=0
0071          TSIG=0
0072          NSHR=0
0073          WRITE(1,4410)
0074   4410   FORMAT ( "IN THE FOLLOWING DIALOG, 1 = YES, 0 = NO."  )
0075          WRITE(1,4411)
0076   4411   FORMAT ( "SUPPRESS WT REVERSALS? ")
0077          READ(1,*)  NPOS
0078          WRITE(1,4412)
0079   4412   FORMAT ( "MULT WTS BY 1000?  ")
0080          READ(1,*) MULT
0081          WRITE(1,4413)
0082   4413   FORMAT ( "SET MEAN OF PREDICTED SCORES?  ")
0083          READ(1,*) ICOM
0084          IF(ICOM.EQ.1) WRITE(1,531)
0085   531    FORMAT("&ENTER MEAN: ")
0086          IF(ICOM.EQ.1) READ(1,*) TMN
0087          WRITE(1,4414)
0088   4414   FORMAT ( "SET SD OF PREDICTED SCORES?  ")
0089          READ(1,*) ICOM
0090          IF(ICOM.EQ.1) WRITE(1,545)
0091   545    FORMAT("ENTER SD: ")
0092          IF(ICOM.EQ.1) READ(1,*) TSIG
0093          WRITE(1,4415)
0094   4415   FORMAT ( "SUPPRESS ADDITIONAL SHRUNKEN R ESTIMATES?  ")
0095          READ(1,*) NSHR
0096          AL=L-1-NEX
0097          NPASS=1
0098          WRITE(1,4418)
0099   4418   FORMAT ( "&CHECK ABOVE PARAMETERS, ENTER 1 TO CONTINUE, 0 TO",
0100          $"RESTART: ")
0101          READ(1,*)  ICOMM
0102          IF(ICOMM.EQ.0)GO TO 1000
0103   20000  IF(IUNIT.NE.6)GO TO 2080
0104          WRITE(IUNIT,2010)
```

```
0105   2010    FORMAT("1     OUTPUT FROM MULTR2"/" *** SELECTED OPTIONS ***")
0106           WRITE(IUNIT,2020)L,N,FVAL
0107   2020    FORMAT(" # VBS = ",I3/" # SS = ",I3/" F-VALUE = ",F7.0)
0108   C ..... PRINT OPTIONS SELECTED
0109           IF(NFRCE.GT.0)WRITE(IUNIT,2030)(KFRCE(I),I=1,NFRCE)
0110   2030    FORMAT(" FORCING SEQUENCE: ",10I3)
0111           IF(NPOS.GT.0)WRITE(IUNIT,2040)
0112   2040    FORMAT(" WT. REVERSALS SUPPRESSED.")
0113           IF(NEX.GT.0)WRITE(IUNIT,2050)(NX(I),I=1,NEX)
0114   2050    FORMAT(//" VBS. EXCLUDED: ",10I3)
0115           IF(TMN.GT.0.)WRITE(IUNIT,2060)TMN
0116   2060    FORMAT(" ESTABLISH MEAN OF PREDICTED SCORES AT: ",F10.3)
0117           IF(TSIG.GT.0.)WRITE(IUNIT,2070)TSIG
0118   2070    FORMAT(" ESTABLISH STANDARD DEVIATION OF PREDICTED SCORES AT:"
0119           $,F10.3," (SD OF CRIT. WILL EQU: (SD OF PRED SCORE)/R1")
0120   2080    NFA=NFRCE
0121           CALL EXEC(9,NAM1)
0122           END
0123           END$
```
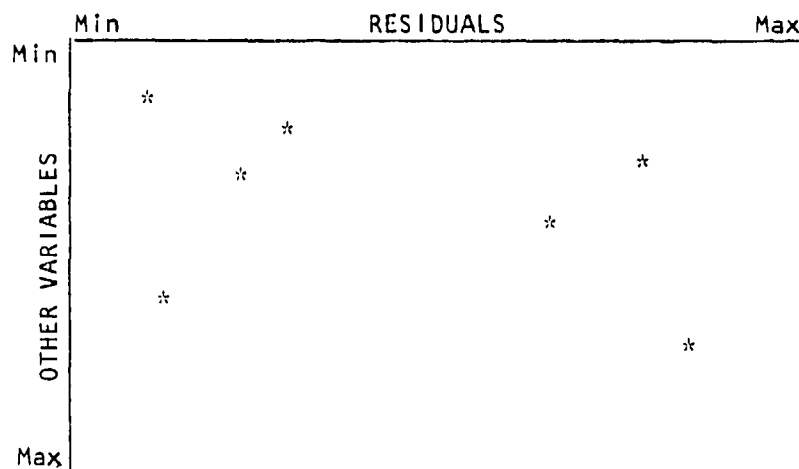
RESID   (Residual Plot)

Purpose:

This program is used to calculate residuals from data obtained from
the MRMAIN program and to plot the residuals against Y-HAT or another
independent variable.

Graphic Display:

User Considerations and Procedures:

1. Program reads off magnetic tape, Y-criterion and Y-predicted
    values created by MRMAIN (see MRMAIN). RESID then calculates
    the residuals by the formula:

    Residuals = (Y-predicted) - (Y-criterion).

2. Option: enter 0 to plot Y-HAT (Y-predicted) vs residuals; enter
    variable number of raw data file to plot that independent variable
    vs residuals; enter -999 to end program.

3. Enter number of observations (program plots out residual for
    each observation).

4. Enter number of variables on raw data file.

5. Enter name of raw data file.

6. Enter format and record length of raw data file.

7. Enter 1 for CRT display or 6 for line printer display of data.

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Comments:

If the device chosen for display was the CRT, the program trans-
fers the CRT graph to hardcopy before doing another plot. If a
hardcopy is not desired, turn hardcopy unit off.

On line printer output, a cleaner representation can be obtained
by turning the paper over so there are no lines on the printed page.

```
RU,RESID
PROGRAM TO ANALYSE RESIDUALS BY PLOTTING YHAT VS
RESIDUALS AND/OR ANY INDEPENDENT VARIABLE VS RESIDUALS


ENTER Ø TO PLOT YHAT
   VAR # TO PLOT THAT VARIABLE
    -999 TO STOP

Ø
ENTER NUMBER OF OBSERVATIONS
32
ENTER NUMBER OF VARIABLES
8
ENTER NAME OF DATA FILE NAME
#FATAA
ENTER FORMAT OF RAW DATA
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA3Ø
64
ENTER 1 FOR CRT, OR 6 FOR LINEPRINTER GRAPH
6


ENTER Ø TO PLOT YHAT
   VAR # TO PLOT THAT VARIABLE
    -999 TO STOP
2

ENTER Ø TO PLOT YHAT
   VAR # TO PLOT THAT VARIABLE
    -999 TO STOP
-999



   :
```

OPTION TAKEN   0

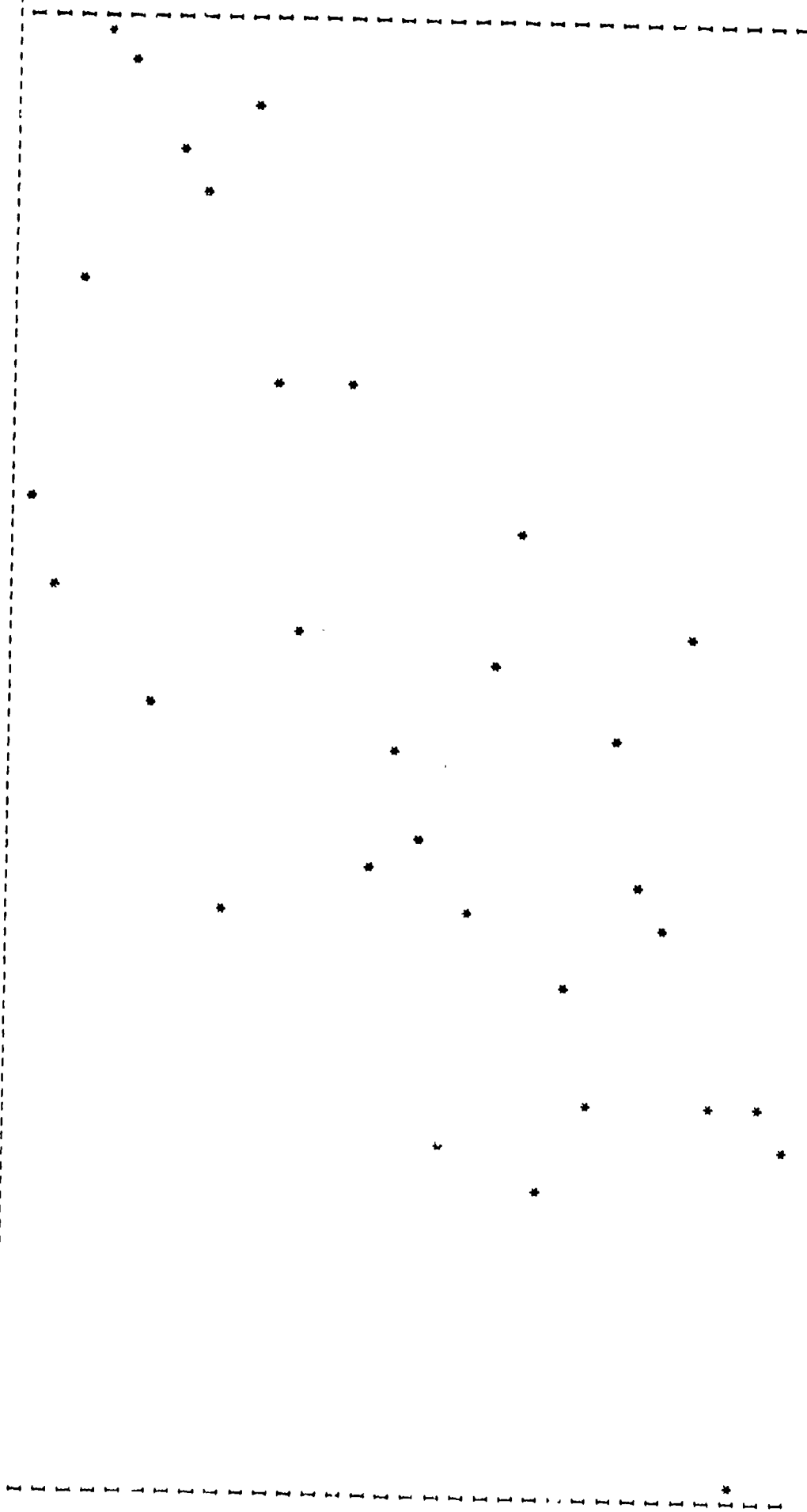YMIN =   -37.6070023   YMAX =   31.9739990

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OPTION TAKEN   2

YMIN =   -37.6070023   YMAX =   31.9739990

YMIN

```
*RESID T=00003 IS ON CR00002 USING 00022 BLKS R=0000

0001   FTN4,L,A
0002          PROGRAM RESID
0003          COMMON IUNIT,NSUB,X(2,1000),Y(30),IBUF(256),IB(272)
0004          COMMON IFMT(20),NAME(3),IC(120),ID(75)
0005          DO 10 I=1,120
0006   10     IC(I)=2H
0007          DO 234 I=1,75
0008   234    ID(I)=2H
0009          IC(1)=1H
0010          IC(2)=1HY
0011          IC(3)=1HM
0012          IC(4)=1HI
0013          IC(5)=1HN
0014          IC(102)=1HY
0015          IC(103)=1HM
0016          IC(104)=1HA
0017          IC(105)=1HX
0018          DO 103 I=1,5
0019   103    ID(I)=IC(I)
0020          DO 104 I=1,4
0021   104    ID(I+63)=IC(I+101)
0022          I78=15414B
0023          I77=15427B
0024          WRITE(1,1)
0025   1      FORMAT(" PROGRAM TO ANALYSE RESIDUALS BY PLOTTING YHAT VS",
0026          $/," RESIDUALS AND/OR ANY INDEPENDENT VARIABLE VS RESIDUALS")
0027          NTIME=0
0028   2      WRITE(1,3)
0029   3      FORMAT(//"ENTER 0 TO PLOT YHAT ",/,5X,"VAR # TO PLOT THAT ",
0030          $"VARIABLE ",/,"        -999 TO STOP")
0031          READ(1,*) ICOM
0032          IF(ICOM.LT.0) GO TO 999
0033          IF(NTIME.NE.0) GO TO 100
0034          WRITE(1,4)
0035   4      FORMAT("ENTER NUMBER OF OBSERVATIONS")
0036          READ(1,*) NSUB
0037          NTIME=NTIME+1
0038          WRITE(1,5)
0039   5      FORMAT("ENTER NUMBER OF VARIABLES")
0040          READ(1,*) NVAR
0041          WRITE(1,6)
0042   6      FORMAT("ENTER NAME OF DATA FILE NAME")
0043          READ(1,7) NAME
0044   7      FORMAT(3A2)
0045          WRITE(1,8)
0046   8      FORMAT("ENTER FORMAT OF RAW DATA")
0047          READ(1,9) IFMT
0048   9      FORMAT(20A2)
0049          IDCBS=256
0050          CALL OPEN(IB,IERR,NAME,3,0,-2,IDCBS)
0051          IF(IERR.GE.0) GO TO 77
0052          WRITE(1,78) NAME,IERR
0053   78     FORMAT(5X,3A2," FAILED TO OPEN ",I5," ERROR #")
0054          STOP
```

```
0055   77      WRITE(1,4403)
0056   4403    FORMAT("ENTER 1 FOR CRT , OR 6 FOR LINEPRINTER GRAPH")
0057           READ(1,*) IUNIT
0058           IF(IUNIT.NE.1) GO TO 100
0059           WRITE(1,83) I77,I78
0060   83      FORMAT("TURN OF HARD COPY UNIT POWER, IF HARD COPY",/,5X,
0061           $"IS NOT DESIRED",2A2)
0062   100     CONTINUE
0063           CALL RWNDF(IB)
0064           REWIND 8
0065           DO 15 I = 1,NSUB
0066           READ(8,11) CRIT,YHAT
0067   11      FORMAT(2(5X,F10.3))
0068           RES=YHAT-CRIT
0069           IF(ICOM.EQ.0) GO TO 20
0070           CALL READF(IB,IER,IBUF)
0071           CALL CODE
0072           READ(IBUF,IFMT) (Y(J),J=1,NVAR)
0073           X(1,I)=Y(ICOM)
0074           GO TO 21
0075   20      X(1,I)=YHAT
0076   21      X(2,I)=RES
0077   15      CONTINUE
0078           CALL SORT(YMIN,YMAX)
0079           IF(IUNIT.EQ.1) GO TO 59
0080           WRITE(6,55) ICOM
0081   55      FORMAT("1   OPTION TAKEN",I7,/)
0082           GO TO 63
0083   59      WRITE(1,84) I78
0084   84      FORMAT(A2)
0085           WRITE(1,55) ICOM
0086   63      WRITE(IUNIT,56) YMIN,YMAX
0087   56      FORMAT(" YMIN = ",F14.7,5X,"YMAX = ",F14.7,/)
0088           IF(YMIN.LT.0.AND.YMAX.GT.0) GO TO 57
0089           IF(IUNIT.EQ.1) GO TO 65
0090           WRITE(6,16)
0091   16      FORMAT(3X,"YMIN",97X,"YMAX")
0092           GO TO 66
0093   65      WRITE(1,17)
0094   17      FORMAT("YMIN",58X,"YMAX")
0095           GO TO 66
0096   57      RANGE=YMAX-YMIN
0097           Z=-YMIN/RANGE
0098           IF(IUNIT.EQ.1) GO TO 67
0099           IV=99.*Z+.5
0100           IF(IV.GT.5.AND.IV.LT.98) GO TO 70
0101           WRITE(6,16)
0102           GO TO 66
0103   70      IC(IV+3)=1H0
0104           WRITE(6,71) (IC(I),I=1,105)
0105   71      FORMAT(105A1)
0106           IC(IV+3)=1H
0107           GO TO 66
0108   67      IV=59.*Z+.5
0109           IF(IV.GT.5.AND.IV.LT.58) GO TO 72
0110           WRITE(1,17)
0111           GO TO 66
```

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```
0112   72      ID(IV+3)=1H0
0113           WRITE(1,73) (ID(I),I=1,67)
0114   73      FORMAT(67A1)
0115           ID(IV+3)=1H
0116   66      CONTINUE
0117           IF(IUNIT.EQ.1) WRITE(1,564)
0118   564     FORMAT(70("_"),/)
0119           IF(IUNIT.EQ.6) WRITE(6,566)
0120   566     FORMAT(110("_"))
0121           CALL STD(YMIN,YMAX)
0122           CALL PPLOT
0123           IF(IUNIT.EQ.1) WRITE(1,569) I77,I78
0124   569     FORMAT(2A2)
0125           GO TO 2
0126   999     WRITE(1,30)
0127   30      FORMAT(///,"RESIDUAL ANALYSIS COMPLETE")
0128           CALL CLOSE(IB)
0129           REWIND 8
0130           END
0131           SUBROUTINE STD(XMIN,XMAX)
0132           COMMON IUNIT,NSUB,X(2,1000)
0133           RANGE=XMAX-XMIN
0134           DO 10 I=1,NSUB
0135   10      X(2,I)=(X(2,I)-XMIN)/RANGE
0136           RETURN
0137           END
0138           SUBROUTINE PPLOT
0139           COMMON IUNIT,NSUB,X(2,1000)
0140           DIMENSION IA(100)
0141           DATA ISTAR/1H*/,IBLANK/1H /
0142           DO 10 I=1,NSUB
0143           DO 20 L=1,100
0144   20      IA(L)=IBLANK
0145           ZK=59.
0146           IF(IUNIT.EQ.6) ZK=99.
0147           Z=X(2,I)
0148           J=ZK*Z + 1
0149           IA(J)=ISTAR
0150           IF(IUNIT.EQ.1) GO TO 30
0151           WRITE(IUNIT,1) IA
0152   1       FORMAT(4X,"I",100A1,"I")
0153           GO TO 10
0154   30      WRITE(1,2) (IA(M),M=1,60)
0155   2       FORMAT(3X,"I",60A1,"I")
0156   10      CONTINUE
0157           RETURN
0158           END
0159           SUBROUTINE SORT(YMIN,YMAX)
0160           COMMON IUNIT,NSUB,X(2,1000)
0161           YMIN=X(2,1)
0162           YMAX=YMIN
0163           DO 10 I=1,NSUB
0164           YMIN=AMIN1(YMIN,X(2,I))
0165           YMAX=AMAX1(YMAX,X(2,I))
0166   10      CONTINUE
0167           N1=NSUB-1
0168           DO 1 I=1,N1
```

```
0169          J=1+I
0170          DO 2 K=J,NSUB
0171          IF(X(1,I).LE.X(1,K)) GO TO 2
0172          TEMP=X(1,I)
0173          X(1,I)=X(1,K)
0174          X(1,K)=TEMP
0175          TEMP=X(2,I)
0176          X(2,I)=X(2,K)
0177          X(2,K)=TEMP
0178   2      CONTINUE
0179       1  CONTINUE
0180          RETURN
0181          END
0182          END$
```

FATAA   (Factor Analysis)

Purpose:

    FATAA computes principal components of a correlation matrix and, optionally, follows with a principal factor analysis using squared multiple correlations as communality estimates. If desired, the principal factor analysis may be iterated until commonalities stabilize with n an specified tolerance.

    Principal components analysis may be run alone or used as a beginning point for the factor analysis. In the factor analysis, the number of factors extracted will be equal to the number of eigenvalues from the rincipal components analysis which are greater than one, unless a smaller number is specified.

    As with any analysis involving matrix inversion, care should be taken not to include variables which are completely predictable from linear combination of other variables included. In practice, variables with very high multiple correlation (.98 or above) are likely to involve inversion problems. The program will detect such linear dependencies, exclude those variables from the analysis, and repeat the analysis with the reduced matrix.

User Considerations and Procedures:

1.   Program SRM30 must be run first to give FATAA initial correlation matrix, variable means, standard deviation, and variable names.

2.   Program has option for calling varimax rotation program. If this option is used, before running FATAA, enter RP, VARI. After FATAA and VARI is complete enter 'OF, VARI'.

3.   Program uses disc files 'SCRTCH' and 'REDMTX'. These should never be purged from disc. Also, program creates user files for other programs such as for varimax rotation. These should be treated as regular data files and should be purged (deleted) from the disc when not needed.

4.   Initial options and parameters:

    a.   option for device output, enter 1 for CRT output or 6 for line printer

    b.   enter number of variables from SRM30 (maximum 30)

    c.   enter 1 for principal component solution only, enter 0 for principal component and principal factor solutions

d. enter maximum number of factors to be extracted (maximum
    of 30). This should not be greater than number of variables.
    A zero value defaults to 30

e. enter maximum number of iterations for principal factor
    solutions. A zero value defaults to 1. NOTE: The more
    iterations requested, the longer the program takes

f. maximum number of iterations for eigenvalue extraction. A
    zero value defaults to 10

g. enter convergence criterion for eigenvalue extraction. A
    zero value defaults to .01

h. enter convergence criterion for stabilization of communalities.
    Iteration will stop when all communalities change less than
    this value across iterations. A zero value defaults to .01,
    which is considered stringent. For a moderately unstable
    solution, .03 or .05 is better

i. enter number of variables to be excluded from the analysis

j. enter 1 for a printout of intermediate results, otherwise
    enter 0. This option slows down the program and should
    only be used when convergence is uncertain

k. enter lowest acceptable eigenvalue (for consideration as a
    factor). A zero value defaults to 1.00

l. enter the numbers of variables to exclude in any order,
    separated by commas. (If response to option i was 0, this
    option does not occur)

m. name of output file for principal component solution

n. name of output file for principal factor solution, if optioned
    for

o. enter 1 to call varimax rotation program (VARI); else enter 0.
    (See (2) User Considerations and Procedures.) NOTE: After FATAA
    is finished, you can call VARI by hand, by entering RU, VARI.
    All options for varimax rotation program is given in VARI.

5. Printout gives:

a. rank of matrix, determinant, and a list of variables eliminated
    during inversion due to linear dependencies

b. final r matrix, after exclusions and eliminations

c. principal components solution

1) number of factors with eigenvalues greater than 1.0
2) total percent of variance explained by the number of factors extracted
3) estimated common variance
4) for each factor, eigenvalue and percent of variance explained
5) commonality for each variable
6) factor loading matrix

d. correlation matrix with squared multiple correlations in diagonal

e. principal factor solution

1) if iterated, commonality for each iteration and its change from preceding iteration, and factor matrix if elected by option
2) when iterations are completed, output for the principal factor solution corresponding to c-1 through c-6 above

Test Data:

This program was tested using the same data as SRM30 (See SRM30). The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to four or five digit places instead of ten digits.

```
 RP,VARI
:RU,FATAA
PRINCIPAL COMPONENTS/FACTOR ANALYSIS
NOTE:  THIS PROGRAM WILL OPEN/READ/WRITE SEVERAL DISC FILES
   'SCRATCH'; 'REDMTX'; 2 USER FILES
IT WOULD BE PRUDENT TO CHECK FOR EXISTING FILES
BEFORE RUNNING
ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:
6
ENTER # OF VBS. IN MATRIX:
8
ENTER 1 FOR PRINCIPAL COMPONENTS ONLY, 0 FOR PRINCIPAL
COMPONENTS AND PRINCIPAL FACTORS:
0
ENTER MAX # OF FACTORS TO BE EXTRACTED (0 DEFAULTS TO 30):
8
ENTER MAX # OF ITERATIONS OF PRINCIPAL FACTOR SOLUTIONS
(0 DEFAULTS TO 1):
25
ENTER MAX # ITERATIONS FOR EIGEN VALUE EXTRACTION
(0 DEFAULTS TO 10):
50
ENTER CONVERGENCE CRITERION FOR EIGEN VALUE EXTRACTION
(0 DEFAULTS TO .01):
.005
ENTER CRITERION FOR STABILIZING COMMUNALITIES
(0 DEFAULTS TO .01):
.005
ENTER # OF VARIABLES TO BE EXCLUDED BEFORE ANALYSIS:
0
ENTER 1 TO PRINT INTERMEDIATE ITERATIONS, 0 OTHERWISE:
0
ENTER LOWEST ACCEPTABLE EIGEN VALUE
(0 DEFAULTS TO 1.00):
1
COMPUTE PRINCIPAL COMPONENTS
COMPUTE COMMUNALITY
 PRINCIPAL COMPONENTS SOLUTION OUTPUT NOW
PRINT FACTOR MATRIX
ENTER NAME OF THIS OUTPUT FILE:
OUTP1
COMPUTE INVERSE
PRINT FACTOR MATRIX
ENTER NAME OF THIS OUTPUT FILE:
OUTP2
ENTER 1 TO CALL VARIMAX
1
VARIMAX
ENTER 1 FOR CRT OUTPUT, 6 TO LPT:
6
ENTER # OF SETS OF ROTATION (MAX IS 25):
1
```

```
ROTATE WITH & W/OUT GENERAL FACTOR (1=Y, Ø=N):
Ø
ENTER #'S OF FACTORS IN EACH SET TO BE ROTATED FROM SMALLEST TO LARGEST:
3
WOULD YOU PREFER TO SKIP THE PRINCIPAL COMPONENT
 SOLUTION AND PERFORM ONLY THE PRINCIPAL AXIS SOLUTION?
(1=Y, Ø=N):
Ø
MS1, NV =    8
 ENTER NAME OF FILE CONTAINING FACTOR MATRIX FOR  PRINCIPAL COMPONENTS:
OUTP1
MS2,NFR =    3
BIG LOOP THRU NX SETS OF SEPARATE ROTATION PROBLEMS
OBTAIN RESIDUAL CORRELATIONS
 ENTER NAME OF FILE CONTAINING FACTOR MATRIX FOR PRINCIPAL AXIS SOLUTION:
OUTP2
MS2,NFR =    3
BIG LOOP THRU NS SETS OF SEPARATE ROTATION PROBLEMS
OBTAIN RESIDUAL CORRELATIONS
ENTER 1 TO CONTINUE, Ø TO END RUN:
Ø
  VARI  :  STOP    ØØØØ
Ø
  FATAA :  STOP    ØØØØ
:OF,VARI
VARI ABORTED
:
```

NUMBER OF VARIABLES. . . . . : 8
RANK OF MATRIX . . . . . . : 8
DETERMINANT. . . . . . . : .1946902E-03

CORRELATION MATRIX

		1	2	3	4	5	6	7	8
A	1	1.0000							
B	2	.2301	1.0000						
C	3	-.2057	.3379	1.0000					
D	4	-.2388	-.2689	.4819	1.0000				
E	5	-.2014	-.2920	.4241	.9689	1.0000			
F	6	-.2070	-.1948	.4659	.9375	.8408	1.0000		
G	7	-.3045	-.1690	.492(	.6105	.6300	.4869	1.0000	
H	8	-.3451	-.3307	.0846	.3755	.4281	.2326	.6872	1.0000

PRINCIPAL COMPONENTS SOLUTION

FACTOR EXTRACTION STATISTICS

NUMBER OF FACTORS . . . . . : 3
PERCENT OF VARIANCE . . . . : .8230
ESTIMATED COMMON VARIANCE . : 1.0000

FACTOR	EIGENVALUE	PERCENT VARIANCE	CUMULATIVE PERCENT
1	4.0257	.5032	.5032
2	1.4783	.1848	.6880
3	1.0802	.1350	.8230

COMMUNALITIES

VARIABLE		COMMUNALITY
A	1	.5316
B	2	.8506
C	3	.8531
D	4	.9852
E	5	.9308
F	6	.8982
G	7	.7763
H	8	.7583

FACTOR MATRIX

	1	2	3
A 1	.4035	.3209	-.5155
B 2	.3052	.7904	.3644
C 3	-.5507	.6546	.3484
D 4	-.9429	.1252	-.2836
E 5	-.9240	.0611	-.2708
F 6	-.8559	.2173	-.3442
G 7	-.8013	-.0678	.3600
H 8	-.5908	-.5009	.3980

CORRELATION MATRIX

	1	2	3	4	5	6	7	8
A 1	.2396							
B 2	.2301	.4440						
C 3	-.2057	.3379	.6198					
D 4	-.2388	-.2689	.4819	.9922				
E 5	-.2014	-.2920	.4241	.9689	.9798			
F 6	-.2070	-.1948	.4659	.9375	.8408	.9604		
G 7	-.3045	-.1630	.4920	.6105	.6300	.4863	.7055	
H 8	-.3451	-.3307	.0846	.3755	.4281	.2326	.6872	.6021

NOTE: DIAGONAL ENTRIES ARE SQUARED MULTIPLE CORRELATIONS OF EACH VARIABLE WITH THE OTHER N-1 VARIABLES.

FACTOR EXTRACTION STATISTICS

```
NUMBER OF FACTORS . . . . .         3
PERCENT OF VARIANCE . . . .       .7276
ESTIMATED COMMON VARIANCE .       .7276
```

FACTOR	EIGENVALUE	PERCENT VARIANCE	CUMULATIVE PERCENT
1	3.8808	.4851	.4851
2	1.1342	.1418	.6269
3	.8059	.1007	.7276

COMMUNALITIES

VARIABLE	COMMUNALITY
A	.1605
B	.5957
C	.7442
D	1.0626
E	.8862
F	.8556
G	.8211
H	.6950

FACTOR MATRIX

	1	2	3
A	.3185	-.1727	-.1709
B	.2777	-.6648	.2768
C	-.5322	-.5910	.3343
D	-.9874	-.0869	-.2831
E	-.9205	-.0123	-.1969
F	-.8590	-.2269	-.3164
G	-.7728	.1255	.4562
H	-.5437	.4881	.4014

VARIABLES UNDER ANALYSIS

A	B	C	D	E	F	G	H
OUTP1							
1 1	.4034796	.3051817	-.5507126	-.9429269	-.9239882	-.8559079	-.8012877
1 2	-.5907568						
2 1	.3209112	.7903879	.6545957	.1251977	.0610765	.2172822	-.0678236
2 2	-.5009069						
3 1	-.5155404	.3644105	.3483532	-.2836099	-.2708402	-.3441698	.3600312
3 2	.3980054						

ITER. 1   3 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES
ITER. 2   3 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES
ITER. 3   2 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES
ITER. 4   0 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES

PRINCIPAL COMPONENTS SOLUTION

KAISER VARIMAX ROTATED FACTOR MATRIX
8 VARIABLES X 3 FACTORS

VAR IDEN #

		1	2	3
A	1	.035	-.007	-.728
B	2	.247	.851	-.255
C	3	-.463	.764	.234
D	4	-.968	.004	.220
E	5	-.931	-.045	.249
F	6	-.942	.048	.089
G	7	-.506	.162	.702
H	8	-.208	-.200	.822

SUM OF FACTOR LDGS SQD 3.268   1.379   1.937
PERCENT OF VARIANCE   40.852 17.236 24.214

TOTAL PERCENT OF VARIANCE OF 3 FACTORS = 82.303

RESIDUAL CORRELATION MATRIX – 3 FACTORS EXTRACTED
UPR RH–ORIGINAL CORRELATIONS
DIAGONAL=COMMUNALITY
LWR LH=RESIDUAL CORRELATIONS

VAR IDEN #

		1	2	3	4	5	6	7	8
A	1	.532	.230	-.206	-.239	-.201	-.207	-.304	-.345
B	2	.041	.851	.338	-.269	-.292	-.195	-.169	-.331
C	3	-.015	-.138	.853	.482	.424	.466	.492	.085
D	4	-.045	.023	-.021	.985	.969	.938	.610	.376
E	5	.012	.040	-.030	.013	.931	.841	.630	.428
F	6	-.109	.020	-.028	.006	-.057	.898	.487	.233
G	7	-.226	-.002	-.030	-.034	-.009	-.060	.776	.687
H	8	.259	.100	-.051	-.006	.021	-.027	.037	.758

OUTP2

1	1	.3185080	.2777376	-.5321764	-.9873664	-.9204900	-.8390125	-.7728373
1	2	-.5437081						
2	1	-.1727054	-.6647741	-.5909611	-.0869128	-.0122773	-.2269451	.1254906
2	2	.4881231						
3	1	-.1709202	.2767981	.3342820	-.2830939	-.1969187	-.3164412	.4561766
3	2	.4014435						

ITER.   1   3 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES
ITER.   2   3 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES
ITER.   3   2 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES
ITER.   4   0 ROTATIONS OUT OF   3 MORE THAN   .01 DEGREES

PRINCIPAL AXIS SOLUTION.

KAISER VARIMAX ROTATED FACTOR MATRIX

8 VARIABLES X 3 FACTORS

VAR IDENT #	1	2	3
A	1	.133	-.034	-.376
B	2	.204	-.690	-.280
C	3	-.417	-.713	.248
D	4	-.980	.008	.319
E	5	-.863	.031	.376
F	6	-.909	-.082	.147
G	7	-.376	-.188	.803
H	8	-.124	.164	.808

SUM OF FACTOR LDGS SQD   2.922   1.055   1.844
PERCENT OF VARIANCE   36.523   13.192   23.046
TOTAL PERCENT OF VARIANCE OF   3 FACTORS =   72.762

RESIDUAL CORRELATION MATRIX - 3 FACTORS EXTRACTED
UPR RH-ORIGINAL CORRELATIONS
DIAGONAL=COMMUNALITY
LWR LH=RESIDUAL CORRELATIONS

VAR IDEN #		1	2	3	4	5	6	7	8
A	1	.160	.230	-.206	-.239	-.201	-.207	-.304	-.345
B	2	.074	.596	.338	-.269	-.292	-.195	-.169	-.331
C	3	-.081	.000	.744	.482	.424	.466	.492	.085
D	4	.012	.026	-.000	1.063	.969	.938	.610	.376
E	5	.056	.010	-.007	.003	.886	.841	.630	.428
F	6	-.033	-.025	-.009	-.000	.003	.656	.487	.233
G	7	.041	.003	.002	-.013	.010	.011	.821	.687
H	8	-.019	.034	-.050	-.005	.013	.014	.023	.695

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```
0001   FTN4
0002        PROGRAM FATAA
0003        INTEGER XID
0004        DIMENSION X(30),COM(30),Y(30),INFILE(3),IFMT(20),IOFILE(3)
0005        DIMENSION ISIZE(2)
0006        COMMON NELVA(30),XID(30,4),NEX
0007        COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0008        DIMENSION IB(272),IBUF(256),IDA(3),IRDX(3),ISCR(3),NVARI(3)
0009        DATA NVARI/2HVA,2HRI,2H  /
0010        DATA ISCR/2HSC,2HRT,2HCH/
0011        DATA IRDX/2HRE,2HDM,2HTX/
0012        DATA IDA/2HSR,2HDA,2HTA/
0013        WRITE(1,4400)
0014   4400 FORMAT ( "PRINCIPAL COMPONENTS/FACTOR ANALYSIS" )
0015        WRITE(1,4401)
0016   4401 FORMAT("NOTE: THIS PROGRAM WILL OPEN/READ/WRITE SEVERAL DISK ",
0017       $"FILES")
0018        WRITE(1,4402)
0019   4402 FORMAT ( "  'SCRATCH'; 'REDMTX'; 2 USER FILES"  )
0020        WRITE(1,4403)
0021   4403 FORMAT ( "IT WOULD BE PRUDENT TO CHECK FOR EXISTING FILES"  )
0022        WRITE(1,4404)
0023   4404 FORMAT ( "BEFORE RUNNING" )
0024        WRITE(1,4405)
0025   4405 FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FOR LPT OUTPUT:  ")
0026        READ(1,*) IUNIT
0027   1500 WRITE(1,4406)
0028   4406 FORMAT ( "ENTER # OF VBS. IN MATRIX: ")
0029        READ(1,*)  NV
0030        WRITE(1,4407)
0031   4407 FORMAT("ENTER 1 FOR PRINCIPAL COMPONENTS ONLY,0 FOR PRINCIPAL")
0032        WRITE(1,4408)
0033   4408 FORMAT ( "COMPONENTS AND PRINCIPAL FACTORS:   ")
0034        READ(1,*) NTYP
0035        WRITE(1,4409)
0036   4409 FORMAT( "ENTER MAX # OF FACTORS TO BE EXTRACTED (0 DEFAULTS ",
0037       X"TO 30):")
0038        READ(1,*) MAXFAC
0039        WRITE(1,4410)
0040   4410 FORMAT("ENTER MAX # OF ITERATIONS OF PRINCIPAL FACTOR ",
0041       C"SOLUTIONS")
0042        WRITE(1,4411)
0043   4411 FORMAT ( "(0 DEFAULTS TO 1): ")
0044        READ(1,*) MAXIT
0045        WRITE(1,4412)
0046   4412 FORMAT ( "ENTER MAX # ITERATIONS FOR EIGENVALUE EXTRACTION "  )
0047        WRITE(1,4413)
0048   4413 FORMAT ( "(0 DEFAULTS TO 10):  ")
0049        READ(1,*) ITMAX
0050        WRITE(1,4414)
```

```
0051   4414   FORMAT("ENTER CONVERGENCE CRITERION FOR EIGENVALUE EXTRACTION")
0052          WRITE(1,4415)
0053   4415   FORMAT ( "(0 DEFAULTS TO .01): ")
0054          READ(1,*)  EPS
0055          WRITE(1,4416)
0056   4416   FORMAT ( "ENTER CRITERION FOR STABILIZING COMMUNALITIES " )
0057          WRITE(1,4417)
0058   4417   FORMAT ( "(0 DEFAULTS TO .01): ")
0059          READ(1,*)  CRIT
0060          WRITE(1,4418)
0061   4418   FORMAT("ENTER # OF VARIABLES TO BE EXCLUDED BEFORE ANALYSIS: ")
0062          READ(1,*)  HEX
0063          WRITE(1,4419)
0064   4419   FORMAT("ENTER 1 TO PRINT INTERMEDIATE ITERATIONS,0 OTHERWISE:")
0065          READ(1,*)  IGEN
0066          WRITE(1,4420)
0067   4420   FORMAT ( "ENTER LOWEST ACCEPTABLE EIGENVALUE "  )
0068          WRITE(1,4421)
0069   4421   FORMAT ( "(0 DEFAULTS TO 1.00):  ")
0070          READ(1,*) AYGN
0071          IF(MAXFAC.EQ.0)MAXFAC=30
0072          IF(MAXIT.EQ.0)MAXIT=1
0073          IF(ITMAX.EQ.0)ITMAX=10
0074          IF(EPS.EQ.0)EPS=.01
0075          IF(CRIT.EQ.0)CRIT=.01
0076          IF(AYGN.EQ.0)AYGN=1.00
0077          IF(HEX.EQ.0)GO TO 1492
0078          WRITE(1,4422)
0079   4422   FORMAT ( "ENTER #'S CF VBS TO EXCLUDE, ANY ORDER:  ")
0080          READ(1,*) (HELVA(I),I=1,HEX)
0081   1492   CONTINUE
0082          IPUN=0
0083   74     CALL OPEN(IB,IER,IDA,3,0,-2,256)
0084          IF(IER.GE.0)GO TO 745
0085          WRITE(1,4428) IER
0086   4428   FORMAT ( "SRDATA FILE FAILED TO OPEN, IER = ",I5 )
0087          STOP
0088   745    DO 10 I=1,30
0089          CALL READF(IB,IER,IBUF)
0090          CALL CODE
0091          READ(IBUF,94) (R(J,I),J=1,30)
0092   10     CONTINUE
0093   94     FORMAT(30(2X,F10.4))
0094          CALL READF(IB,IER,IBUF,256,LEN,61)
0095          CALL CODE
0096          READ(IBUF,94) X
0097          CALL READF(IB,IER,IBUF)
0098          CALL CODE
0099          READ(IBUF,94) COM
0100          CALL READF(IB,IER,IBUF)
0101          CALL CODE
0102          READ(IBUF,808) ((XID(I,J),J=1,4),I=1,30)
0103   808    FORMAT(30(4X,4A2)
0104          CALL CLOSE(IB)
0105          CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0106          IF(HEX.NE.0)CALL REDC(NV,0)
0107   251    DO 252 I=1,30
```

```
0108        CALL CODE
0109        WRITE(IBUF,747)(R(I,J),J=1,30)
0110  747   FORMAT(30(2X,F12.5))
0111  252   CALL WRITF(IB,IER,IBUF)
0112  253   CONTINUE
0113        CALL CLOSE(IB,IER)
0114        WRITE(IUNIT,1894)NV
0115  1894  FORMAT(//5X,"NUMBER OF VARIABLES......",2X,I2)
0116        DETER=SIML(NV)
0117        IF(NEX.NE.0)CALL REDC(NV,1)
0118        WRITE(IUNIT,1895)NV,DETER
0119  1895  FORMAT(5X,"RANK OF MATRIX............",2X,I2/5X,
0120       X"DETERMINANT...............",2X,E14.7)
0121        IF(NEX.EQ.0)GO TO 2600
0122  1896  FORMAT(5X,"VARIABLES ELIMINATED.....",2X,I3)
0123        WRITE(IUNIT,1896)NEX
0124        DO 1897  I=1,NEX
0125        KP=NELVA(I)
0126  1897  WRITE(IUNIT,1898)(XID(KP,J),J=1,4)
0127  1898  FORMAT(32X,4A2)
0128  2600  DO 80 I=1,NV
0129  80    X(I)=1.0-(1.0/R(I,I))
0130        NV=NV+NEX
0131        CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0132        DO 2602 I=1,30
0133        CALL READF(IB,IER,IBUF)
0134        CALL CODE
0135  2602  READ(IBUF,747)(R(I,J),J=1,30)
0136        CALL CLOSE(IBUF,IER)
0137        IF(NEX.EQ.0)GO TO 2345
0138        CALL REDC(NV,0)
0139        CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0140        DO 38 I=1,30
0141        CALL CODE
0142  38    WRITE(IBUF,747)(R(I,J),J=1,30)
0143        CALL CLOSE(IB,IER)
0144        WRITE(1,4429)
0145  4429  FORMAT ( "PRINT R MATRIX" )
0146  2345  CALL RPRT(1,NV)
0147        CALL OPEN(IB,IER,IRDX,3,0,-2,256)
0148        IF(IER.GE.0)GO TO 2344
0149        WRITE(1,4430) IER
0150  4430  FORMAT ( "REDMTX FILE FAILED TO OPEN, IER = ",I5 )
0151        STOP
0152  2344  CALL CODE
0153        WRITE(IBUF,2093)NV
0154        CALL WRITF(IB,IER,IBUF)
0155        DO 2346 I=1,30
0156        CALL CODE
0157        WRITE(IBUF,747)(R(I,J),J=1,30)
0158  2346  CALL WRITF(IB,IER,IBUF)
0159  2347  CALL CODE
0160        WRITE(IBUF,808)((XID(I,J),J=1,4),I=1,30)
0161        CALL WRITF(IB,IER,IBUF)
0162        CALL CLOSE (IB,IER)
0163        IF(NTYP.EQ.2)GO TO 4300
0164        WRITE(1,4431)
0165  4431  FORMAT ( "COMPUTE PRINCIPLE COMPONENTS" )
```

```
0166          CALL EXTC(NV,ITMAX,EPS,IGEN,PCT)
0167          TVAR=0.0
0168          DO 120 J=1,NV
0169          IF(EIGEN(J).LT.AVGN)GO TO 135
0170          TVAR=TVAR+VAR(J)
0171          IF(J.EQ.MAXFAC)GO TO 130
0172    120   CONTINUE
0173    130   NFAC=J
0174          GO TO 140
0175    135   NFAC=J-1
0176          WRITE(1,4432)
0177    4432  FORMAT ( "COMPUTE COMMUNALITY"  )
0178    140   DO 150 I=1,NV
0179          COM(I)=0
0180          DO 150 J=1,NFAC
0181          T(I,J)=T(I,J)*SQRT(EIGEN(J))
0182    150   COM(I)=COM(I)+T(I,J)*T(I,J)
0183          IF(IUNIT.EQ.6) WRITE(1,4090)
0184    4090  FORMAT(" PRINCIPAL COMPONENTS SOLUTION OUTPUT NOW ")
0185          WRITE(IUNIT,303)
0186    303   FORMAT("     PRINCIPAL COMPONENTS SOLUTION")
0187          GO TO 200
0188    2001  CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0189          WRITE(1,4433)
0190    4433  FORMAT ( "COMPUTE INVERSE"  )
0191    2003  DO 2004 I=1,30
0192          CALL READF(IB,IER,IBUF)
0193          CALL CODE
0194    2004  READ(IBUF,747)(R(I,J),J=1,30)
0195    2005  CONTINUE
0196          CALL CLOSE(IB,IER)
0197          NTYP=NTYP+1
0198          DO 90 I=1,NV
0199    90    R(I,I)=X(I)
0200          CALL RPRT (0,NV)
0201          ITER=0
0202    1809  CALL EXTC(NV,ITMAX,EPS,IGEN,PCT)
0203          ITER=ITER+1
0204          TVAR=0
0205          DO 2250 I=1,NFAC
0206    2250  TVAR=TVAR+VAR(I)
0207          DO 2150 I=1,NV
0208          COM(I)=0
0209          DO 2150 J=1,NFAC
0210          T(I,J)=T(I,J)*SQRT(EIGEN(J))
0211    2150  COM(I)=COM(I)+T(I,J)*T(I,J)
0212          IF(IGEN.EQ.0) GO TO 1305
0213          WRITE(IUNIT,506)ITER,(J,X(J),COM(J),J=1,NV)
0214    506   FORMAT(///,5X,"ITERATION ",I3//10X,
0215          X"VARIABLE     ESTIMATED     OBSERVED"//
0216          $(13X,I3,2X,F10.4,2X,F10.4))
0217          CALL FPRT(NV,NFAC)
0218    1305  IF(ITER.EQ.MAXIT)GO TO 199
0219          DO 160 J=1,NV
0220          IF(ABS(COM(J)-X(J)).GT.CRIT)GO TO 180
0221    160   CONTINUE
```

```
0222          GO TO 200
0223   180    DO 185 J=1,NV
0224   185    X(J)=COM(J)
0225          CALL OPEN(IB,IER,ISCR,3,0,-2,256)
0226   1841   DO 1842 I=1,30
0227          CALL READF(IB,IER,IBUF)
0228          CALL CODE
0229   1842   READ(IBUF,747)(R(I,J),J=1,30)
0230   1843   CONTINUE
0231          CALL CLOSE(IB,IER)
0232          DO 186 I=1,NV
0233   186    R(I,I)=X(I)
0234          GO TO 1809
0235   199    CONTINUE
0236          IF(IUNIT.EQ.6) WRITE(1,413)
0237   413    FORMAT("PRINCIPAL FACTORS SOLUTION OUTPUT NOW ")
0238          WRITE(IUNIT,302)
0239   302    FORMAT("     PRINCIPAL FACTOR SOLUTION")
0240   200    Y(1)=VAR(1)
0241          DO 205 J=2,NFAC
0242          JM1=J-1
0243   205    Y(J)=Y(JM1)+VAR(J)
0244          WRITE(IUNIT,206) NFAC,TVAR,PCT
0245   206    FORMAT(//" FACTOR EXTRACTION STATISTICS"//10X
0246          1"NUMBER OF FACTORS.........",5X,I5/10X,
0247          2"PERCENT OF VARIANCE......",F10.4/10X,
0248          3"ESTIMATED COMMON VARIANCE",F10.4///
0249          415X,"FACTOR",4X,"EIGENVALUE",4X,"PERCENT VARIANCE",4X,
0250          5"CUMULATIVE PERCENT"//)
0251          WRITE(IUNIT,207)(J,EIGEN(J),VAR(J),Y(J),J=1,NFAC)
0252   207    FORMAT(17X,I2,4X,F10.4,6X,F10.4,11X,F10.4)
0253          WRITE(IUNIT,209) ((XID(I,J),J=1,4),I,COM(I),I=1,NV)
0254   209    FORMAT(4X,"COMMUNALITIES"//" VARIABLE",13X," COMMUNALITY"
0255          1/(5X,4A2,5X,I3,F10.4))
0256          WRITE(1,4435)
0257   4435   FORMAT ( "PRINT FACTOR MATRIX"  )
0258          CALL FPRT(NV,NFAC)
0259          WRITE(1,4436)
0260   4436   FORMAT ( "&ENTER NAME OF THIS OUTPUT FILE:" )
0261          READ(1,809)IOFILE
0262   809    FORMAT(3A2)
0263          ISIZF(1)=63
0264          ISIZE(2)=53
0265          CALL CREAT(IB,IER,IOFILE,ISIZE,2,0,-2,144)
0266          IF(IER.GE.0)GO TO 2094
0267          WRITE(1,4437) IER
020(   '.37   FORMAT ( "OUTPUT FILE FAILED TO OPEN, IER = ",I5 )
026,          STOP
0270   2093   FORMAT(5X,I5)
0271   2094   CALL CODE
0272          WRITE(IBUF,2093)NFAC
0273          CALL WRITF(IB,IER,IBUF)
0274          DO 210 J=1,NFAC
0275          N=0
0276          DO 210 K=1,NV,7
```

```
0277          L=MINO(K+ 6,NV)
0278          M=M+1
0279          CALL CODE
0280          WRITE(IBUF,2095) J,M,(T(I,J),I=K,L)
0281    210   CALL WRITF(IB,IER,IBUF)
0282    2095  FORMAT(2I3,2X,10F10.7)
0283          CALL LOCF(IB,IER,I1,IRB,I1,JSFC)
0284          ITRUN=JSFC/2 - IRB - 1
0285          CALL CLOSE(IB,IER,ITRUN)
0286          IF(NTYP.EQ.0)GO TO 2001
0287          WRITE(1,4438)
0288    4438  FORMAT ( "ENTER 1 TO CALL VARIMAX  ")
0289          READ(1,*) VARI
0290          IF(VARI.EQ.1)CALL EXEC(9,NVARI)
0291    4300  WRITE(1,4439)
0292    4439  FORMAT ( "ENTER 1 TO CONTINUE, 0 TO END RUN: ")
0293          READ(1,*)  NEXT
0294          CALL CLOSE(IB,IER)
0295          IF(NEXT.NE.0)GO TO 1500
0296    3300  STOP
0297          END
0298          SUBROUTINE FPRT(NV,NFAC)
0299          INTEGER XID
0300          COMMON NELVA(30),XID(30,4),NEX
0301          COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0302          WRITE(IUNIT,1803)
0303    1803  FORMAT(4X,"FACTOR MATRIX")
0304          DO 640 K=1,NFAC,8
0305          L=MINO(K+7,NFAC)
0306          WRITE(IUNIT,460)(J,J=K,L)
0307    460   FORMAT(//12X,8(8X,I3))
0308          DO 640 I=1,NV
0309    640   WRITE(IUNIT,385)(XID(I,J),J=1,4),I,(T(I,J),J=K,L)
0310    385   FORMAT(1X,4A2,2X,I3,3X,8(F7.4,4X))
0311          RETURN
0312          END
0313          SUBROUTINE RPRT(NTYP,NV)
0314          INTEGER XID
0315          COMMON NELVA(30),XID(30,4),NEX
0316          COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0317          WRITE(IUNIT,355)
0318    355   FORMAT(//5X"CORRELATION MATRIX")
0319    400   DO 440 K=1,NV,8
0320          L=MINO(K+7,NV)
0321          WRITE(IUNIT,460)(J,J=K,L)
0322    460   FORMAT(//12X,8(8X,I3))
0323          DO 440 I=K,NV
0324          MD=MINO(L,I)
0325    440   WRITE(IUNIT,385)(XID(I,J),J=1,4),I,(R(I,J),J=K,MD)
0326    385   FORMAT(1X,4A2,2X,I3,3X,8(F7.4,4X))
0327          IF(NTYP.NE.1)WRITE(IUNIT,407)
0328    407   FORMAT(//5X,"NOTE--DIAGONAL ENTRIES ARE SQUARED MULTIPLE
0329         $CORRELATIONS OF EACH VARIABLE WITH THE OTHER N-1 VARIABLES")
0330          RETURN
0331          END
```

243

```
0332          SUBROUTINE EXTC(NV,ITMAX,EPS,IGEN,PCT)
0333          DIMENSION AIK(30)
0334          INTEGER XID
0335          COMMON NELVA(30),XID(30,4),NEX
0336          COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0337          EQUIVALENCE (VAR,AIK)
0338          DO 2 I=1,NV
0339          DO 2 J=1,NV
0340  2       T(I,J)=0
0341          SIG1=0
0342          OFFDSQ=0
0343          DO 5 I=1,NV
0344          SIG1=SIG1+R(I,I)
0345          T(I,I)=1
0346          II=I+1
0347          IF(I.GE.NV)GO TO 6
0348          DO 5 J=II,NV
0349  5       OFFDSQ=OFFDSQ+R(I,J)*R(I,J)
0350  6       S=2*OFFDSQ+SIG1
0351          SIG1D=SIG1
0352          NVV=NV-1
0353          PCT=SIG1D/NV
0354          DO 26 ITER=1,ITMAX
0355          DO 20 I=1,NVV
0356          II=I+1
0357          DO 20 J=II,NV
0358          Q=ABS(R(I,I)-R(J,J))
0359          IF(Q.LE.1.E-7)GO TO 9
0360          IF(ABS(R(I,J)).LE.1.E-7)GO TO 20
0361          P=2*R(I,J)*Q/(R(I,I)-R(J,J))
0362          SPQ=SQRT(P*P+Q*Q)
0363          CSA=SQRT((1+Q/SPQ)/2)
0364          SHA=P/(2*CSA*SPQ)
0365          GO TO 10
0366  9       CSA=1/SQRT(2.0)
0367          SHA=CSA
0368  10      CONTINUE
0369          DO 11 K=1,NV
0370          WT=T(K,I)
0371          T(K,I)=WT*CSA+T(K,J)*SHA
0372  11      T(K,J)=WT*SHA-T(K,J)*CSA
0373          DO 16 K=1,NV
0374          IF(K.GT.J)GO TO 15
0375          AIK(K)=R(I,K)
0376          R(I,K)=CSA*AIK(K)+SHA*R(K,J)
0377          IF(K.NE.J)GO TO 14
0378          R(J,K)=SHA*AIK(K)-CSA*R(J,K)
0379  14      GO TO 16
0380  15      WT=R(I,K)
0381          R(I,K)=CSA*WT+SHA*R(J,K)
0382          R(J,K)=SHA*WT-CSA*R(J,K)
0383  16      CONTINUE
0384          AIK(J)=SHA*AIK(I)-CSA*AIK(J)
0385          DO 19 K=1,J
0386          IF(K.LE.I)GO TO 18
0387          R(K,J)=SHA*AIK(K)-CSA*R(K,J)
```

```
0388          GO TO 19
0389    18    WT=R(K,I)
0390          R(K,I)=CSA*WT+SNA *R(K,J)
0391          R(K,J)=SNA*WT-CSA*R(K,J)
0392    19    CONTINUE
0393    20    R(I,J)=0
0394          SIG2=0
0395          DO 21 I=1,NV
0396          EIGEN(I)=R(I,I)
0397    21    SIG2=SIG2+EIGEN(I)*EIGEN(I)
0398          IF(1-SIG1/SIG2.GE.EPS)GO TO 26
0399          GO TO 30
0400    26    SIG1=SIG2
0401    30    NVV=NV-1
0402          DO 300 I=1,NVV
0403          IP1=I+1
0404          DO 300 J=IP1,NV
0405          IF(EIGEN(I).GE.EIGEN(J))GO TO 300
0406          TEMP=EIGEN(I)
0407          EIGEN(I)=EIGEN(J)
0408          EIGEN(J)=TEMP
0409          DO 250 L=1,NV
0410          AIK(L)=T(L,I)
0411          T(L,I)=T(L,J)
0412    250   T(L,J)=AIK(L)
0413    300   CONTINUE
0414          DO 35 J=1,NV
0415    35    AIK(J)=EIGEN(J)/NV
0416          IF(IGEN.EQ.0)RETURN
0417          WRITE(IUNIT,204)
0418    204   FORMAT("1",4X,"COMPLETE EIGENSTRUCTURE"//)
0419          DO 205 I=1,NV
0420    205   WRITE(IUNIT,201)I,EIGEN(I),AIK(I)
0421    201   FORMAT(5X,I3,2F10.4)
0422          RETURN
0423          END
0424          SUBROUTINE REDC(NV,NTYP)
0425          INTEGER XID
0426          COMMON NELVA(30),XID(30,4),NEX
0427          COMMON R(30,30),T(30,30),EIGEN(30),VAR(30),IUNIT
0428          DIMENSION AIK(30)
0429          EQUIVALENCE (AIK,VAR)
0430          WRITE(1,4400)
0431    4400  FORMAT ( "ORDER VARIABLES TO BE ELIMINATED" )
0432          IF(NEX.EQ.1)GO TO 40
0433          NX=NEX-1
0434          DO 300 I=1,NX
0435          IP1=I+1
0436          DO 300 J=IP1,NEX
0437          IF(NELVA(I).GE.NELVA(J))GO TO 300
0438          NTEMP=NELVA(I)
0439          NELVA(I)=NELVA(J)
0440          NELVA(J)=NTEMP
0441    300   CONTINUE
```

```
0442   40      DO 20 I=1,NEX
0443           M2=NV-1
0444           NEL=NELVA(I)
0445           IF(NEL.EQ.NV)GO TO 19
0446           DO 15 J=NEL,M2
0447           JP1=J+1
0448           DO 15 K=1,NV
0449   15      R(K,J)=R(K,JP1)
0450           DO 17 K=NEL,M2
0451           KP1=K+1
0452           DO 17 J=1,NV
0453   17      R(K,J)=R(KP1,J)
0454           WRITE(1,4401)
0455   4401    FORMAT ( "REDUCE VARIABLE NAMES"   )
0456           IF(NTYP.EQ.1)GO TO 19
0457           DO 18 J=NEL,M2
0458           JP1=J+1
0459           DO 18 K=1,4
0460   18      XID(J,K)=XID(JP1,K)
0461   19      NV=NV-1
0462   20      CONTINUE
0463           RETURN
0464           END
0465           FUNCTION SIML(M)
0466           INTEGER XID
0467           COMMON NELVA(30),XID(30,4),NEX
0468           COMMON R(30,30),EIGEN(30),VAR(30),IUNIT
0469           EQUIVALENCE (A,R)
0470           DIMENSION A(30,30)
0471           NEX=0
0472           DET=1
0473           DO 1 J=1,M
0474           PVT=A(J,J)
0475           IF(PVT.GT.0.01)GO TO 25
0476           NEX=NEX+1
0477           NELVA(NEX)=J
0478           GO  TO 1
0479   25      DET=DET*PVT
0480           A(J,J)=1
0481           DO 2 K=1,M
0482   2       A(J,K)=A(J,K)/PVT
0483           DO 1 K=1,M
0484           IF(K-J)3,1,3
0485   3       T=A(K,J)
0486           A(K,J)=0
0487           DO 4 L =1,M
0488   4       A(K,L)=A(K,L)-A(J,L)*T
0489   1       CONTINUE
0490           SIML=DET
0491   26      RETURN
0492           END
0493           END$
```

VARI   (Varimax Location)

Purpose:

VARI accepts input from factor analysis programs and performs
normalized varimax rotation on the full factor matrix or sets
of the factors.

VARI offers several ways to vary the number of factors rotated.
Since it is often not desirable to rotate all the factor obtained
in a factor analysis, the user can choose to rotate any number of
factors up to the maximum extracted. In addition, sets of various
sizes can be rotated in one program run.

Another option allows the first factor to be treated as a general
and ignored in rotation. If the first factor is truly a general,
so that all variables load on it, the varimax procedures will not
be able to achieve a satisfactory "simple structure" solution. If
a general is suspected, each factor set can be rotated with and
without the first factor to determine differences between the solu-
tions. Factors are rotated pairwise until each rotation required
is less than .01 degrees. Each angle of rotation is selected so as
to maximize the variance of the loadings squared for each factor.
This program can be run apart from FATAA with the 'RU, VARI' com-
mand or as an option of FATAA.

Initial Options and Parameters:

1. Option for device output; enter 1 for CRT display or 6 for line
    printer.

2. Enter number of sets of rotation (maximum is 25, 0 is set to 1).
    If different number of factors from the same analysis are to be
    rotated, this number is equal to the total of all such sets (NS).

3. Enter 1 to rotate each set twice, with and without general factor;
    otherwise, enter 0.

4. Enter the number of factors in each set to be rotated from smallest
    to largest separated by commas. (NOTE: The first set should have
    the smallest number of factors, the last should be largest.) If
    only 1 set, enter number of factors to be rotated in that set.

5. Enter 1 to skip principal component solution and perform only
    principal axes solution; otherwise, enter 0.

6. If asked for, enter name of file containing factor matrix for principal components solution (from FATAA).

7. Enter name of file containing factor matrix for principal axis solution (from FATAA).

8. Enter 1 to restart program, 0 to stop.

Printout Gives:

1. Number of variables and names (in number of factors principal axis solution).

2. Factor matrix from FATAA.

3. For each set of rotations:

   a. during solution, the iteration number and the number of rotations greater than 0.01 degree

   b. when rotation complete

      1) number of variables
      2) number of factors
      3) rotated factor matrix
      4) sum of factor loading squared (for each factor)
      5) percent of variance (for each factor)
      6) total percent of variance
      7) NV x NV matrix with original correlations above the diagonal, commonalities in the diagonal, and residual correlation below the diagonal

Test Data:

This program was tested using the same data as SRM30 (See SRM30). Printout of input parameters and statistical output is presented in the factor analysis calculations (See FATAA). The accuracy of this program is less than that obtained by the Statistical Analysis System. The data analysis output is only accurate to four or five digit places instead of ten digits.

```
0001   FTN4
0002        PROGRAM VARI
0003        INTEGER VID
0004        DIMENSION IPFILE(3),IRMX(3),IB(272),IBUF(256)
0005        COMMON R(30,30),H(30),VID(30,4),F(30,10),
0006       XAIJ(30,10),HI(25),NOM(48)
0007        COMMON NV,NF,CON,MX,FN
0008        DATA IRMX/2HRE,2HDM,2HTX/
0009   1895 FORMAT(" PRINCIPAL COMPONENTS SOLUTION")
0010   1896 FORMAT(" PRINCIPAL AXIS SOLUTION")
0011   505  FORMAT(" ITER.",I3,I5,"ROTATIONS OUT OF ",I5," MORE THAN
0012       $      .01 DEGREES"/)
0013   507  FORMAT(41X," KAISER VARIMAX ROTATED FACTOR MATRIX"/
0014       $46X,I3,"VARIABLES X",I3"FACTORS "/)
0015   508  FORMAT(48X," FACTOR 1 - GENERAL FACTOR"/)
0016   509  FORMAT(/" VAR IDEN #",2X,I3,13(4X,I3))
0017   510  FORMAT(1X)
0018   511  FORMAT(1X,4A2,I4,14F7.3)
0019   512  FORMAT(/" SUM OF FACTOR LDGS SQD",14F7.3)
0020   513  FORMAT(" PERCENT OF VARIANCE ",14F7.3)
0021   514  FORMAT(/" TOTAL PERCENT OF VARIANCE OF ",I3," FACTORS = ",F7.3)
0022   515  FORMAT("1")
0023   516  FORMAT(34X," RESIDUAL CORRELATION MATRIX -",I3," FACTORS ",
0024       $"EXTRACTED",/
0025       $34X," UPR RH-ORIGINAL CORRELATIONS"/34X," DIAGONAL=COMMUNALITY"
0026       $/34X," LWR LH=RESIDUAL CORRELATIONS"/)
0027   517  FORMAT(" ERROR",I3," DOES NOT EQUAL ",I3," MINUS ",I3)
0028        WRITE(1,4400)
0029   4400 FORMAT ( "VARIMAX"  )
0030        WRITE(1,4401)
0031   4401 FORMAT ( "ENTER 1 FOR CRT OUTPUT, 6 FO LPT:   ")
0032        READ(1,*) IUNIT
0033        CON=57.295645
0034   1    WRITE(1,4402)
0035   4402 FORMAT ( "ENTER # OF SETS OF ROTATION (MAX IS 25):   ")
0036        READ(1,*) NS
0037        WRITE(1,4403)
0038   4403 FORMAT ( "ROTATE WITH & W/OUT GENERAL FACTOR (1=Y, 0=N): ")
0039        READ(1,*)  KGEN
0040        WRITE(1,4404)
0041   4404 FORMAT( "ENTER #'S OF FACTORS IN EACH SET TO BE ROTATED",
0042       $"FROM SMALLEST TO LARGEST:")
0043        READ(1,*) (HI(I),I=1,NS)
0044   14   WRITE(1,4405)
0045   4405 FORMAT ( "WOULD YOU PREFER TO SKIP THE PRINCIPAL COMPONENT "  )
0046        WRITE(1,4406)
0047   4406 FORMAT(" SOLUTION AND PERFORM ONLY THE PRINCIPAL AXIS "
0048       C."SOLUTION?")
0049        WRITE(1,4407)
0050   4407 FORMAT ( "(1=Y, 0=N):   ")
```

```
0051         READ(1,*) JACK
0052         CALL OPEN(IB,IER,IRMX,3,0,-2,256)
0053         IF(IER.GE.0)GO TO 1500
0054         WRITE(1,4408) IER
0055    4408 FORMAT ( "REDMTX FILE FAILED TO OPEN, IER = ",I5 )
0056         STOP
0057    1500 CALL READF(IB,IER,IBUF)
0058         CALL CODE
0059         READ(IBUF,1501)NV
0060    1501 FORMAT(5X,I5)
0061         WRITE(1,4409) NV
0062    4409 FORMAT ( "MS1, NV = ",I5  )
0063         DO 1503 I=1,30
0064         CALL READF(IB,IER,IBUF)
0065         CALL CODE
0066         READ(IBUF,1502)(R(I,J),J=1,30)
0067    1502 FORMAT(30(2X,F12.5))
0068    1503 CONTINUE
0069         CALL READF(IB,IER,IBUF)
0070         CALL CODE
0071         READ(IBUF,1504)((VID(I.J),J=1,4),I=1,30)
0072    1504 FORMAT(30(4X,4A2))
0073         CALL CLOSE(IB,IER)
0074    9999 FORMAT(3(2X,10F10.7/))
0075         WRITE(IUNIT,9996)
0076    9996 FORMAT(/5X,"VARIABLES UNDER ANALYSIS")
0077    C    WRITE(IUNIT,9999) ((R(I,J), J=1,30), I=1,30)
0078         WRITE(IUNIT,1504) ((VID(I,J), J=1,4), I=1,NV)
0079    1545 IF(JACK.EQ.0)WRITE (1,432)
0080    432  FORMAT(" ENTER NAME OF FILE CONTAINING FACTOR MATRIX,",
0081         $"FOR PRINCIPAL COMPONENTS SOLUTION:")
0082         IF(JACK.EQ.1) WRITE(1,433)
0083    433  FORMAT(" ENTER NAME OF FILE CONTAINING FACTOR MATRIX ",
0084         $"FOR PRINCIPAL AXIS SOLUTION:")
0085         READ(1,1505)IPFILE
0086    1505 FORMAT(3A2)
0087         CALL OPEN(IB,IER,IPFILE,3,0,-2,144)
0088         IF(IER.GE.0)GO TO 15055
0089         WRITE(1,4410) IER
0090    4410 FORMAT ( "FACTOR MATRIX FILE FAILED TO OPEN, IER = ",I5  )
0091         STOP
0092   15055 CALL READF(IB,IER,IBUF)
0093         CALL CODE
0094         READ(IBUF,1511)NFR
0095    1511 FORMAT(5X,I5)
0096         WRITE(1,4411) NFR
0097    4411 FORMAT ( "MS2,NFR = ",I5 )
0098         WRITE(IUNIT,9997)IPFILE
0099    9997 FORMAT(/11X,3A2//)
0100         DO 1506 J=1, NFR
0101         M=0
0102         DO 1506 K=1,NV,7
0103         L=MIN0(K+6,NV)
0104         M=M+1
0105         CALL READF(IB,IER,IBUF)
0106         CALL CODE
```

```
0107          READ(IBUF,2095) IZ1,IZ2,(AIJ(I,J),I=K,L)
0108   2095   FORMAT(2I3,2X,10F10.7)
0109   1506   CONTINUE
0110          CALL CLOSE(IB,IER)
0111   15075  IGEN=KGEN
0112          FN=NV
0113          IF(NS.EQ.0)NI(1)=NFR
0114          IF(NS.EQ.0)NS=1
0115          JACK=JACK+1
0116          JG=1
0117          IF(IGEN.NE.0)JG=2
0118          WRITE(1,4413)
0119   4413   FORMAT ("BIG LOOP THRU NS SETS OF SEPARATE ROTATION PROBLEMS")
0120   10     DO 100 L=1,NS
0121          NIT=0
0122          IF(L.EQ.1)KA=1
0123          IF(L.NE.1)KA=NI(L-1)+1
0124          NF=NI(L)
0125          DO 8 J=KA,NF
0126          DO 8 I=1,NV
0127   8      F(I,J)=AIJ(I,J)
0128          IF(IGEN.EQ.0)M=NF*(NF-1)/2
0129          IF(IGEN.NE.0)M=(NF-1)*(NF-2)/2
0130          LK=0
0131          DO 9 I=1,NV
0132          H(I)=0
0133          DO 13 J=JG,NF
0134   13     H(I)=H(I)+F(I,J)**2
0135          H(I)=SQRT(H(I))
0136          DO 9 J=JG,NF
0137   9      F(I,J)=F(I,J)/H(I)
0138   20     MX=M
0139          J=NF
0140   11     LF=J-1
0141          DO 12 K=JG,LF
0142   12     CALL CROT(J,K)
0143          J=J-1
0144          IF(J.GT.JG)GO TO 11
0145          NIT=NIT+1
0146          WRITE(IUNIT,505)NIT,MX,M
0147          IF(MX.GT.0)GO TO 20
0148          DO 30 I=1,NV
0149          DO 30 J=JG,NF
0150   30     F(I,J)=F(I,J)*H(I)
0151          KA=1
0152          KB=14
0153          IF(NF.LT.15)KB=NF
0154   40     IF(JACK.EQ.1)WRITE(IUNIT,1895)
0155          IF(JACK.EQ.2)WRITE(IUNIT,1896)
0156          WRITE(IUNIT,507)NV,NF
0157          IF(IGEN.NE.0)WRITE(IUNIT,508)
0158   60     WRITE(IUNIT,509)(J,J=KA,KB)
0159          WRITE(IUNIT,510)
0160          DO 41 I=1,NV
```

```
0161          IF(LK.EQ.0)WRITE(IUNIT,511)(VID(I,J),J=1,4),I,(F(I,J),J=KA,KB)
0162          IF(LK.NE.0)WRITE(IUNIT,511)(VID(I,J),J=1,4),I,(R(I,J),J=KA,KB)
0163    41    CONTINUE
0164          IF(LK.NE.0)GO TO 44
0165          DO 42 J=1,NF
0166          H(J)=0
0167          DO 42 I=1,NV
0168    42    H(J)=H(J)+F(I,J)**2
0169          WRITE(IUNIT,512)(H(J),J=KA,KB)
0170          SUM=0
0171          DO 43 J=1,NF
0172          H(J)=100*H(J)/FN
0173    43    SUM=SUM+H(J)
0174          WRITE(IUNIT,513)(H(J),J=KA,KB)
0175          WRITE(IUNIT,514)NF,SUM
0176    44    KA=KA+14
0177          KB=KB+14
0178          IF(LK.NE.0)GO TO 55
0179          IF(KB.GE.NF)KB=NF
0180          IF(NF.GE.KA)GO TO 40
0181          WRITE(IUNIT,515)
0182          IF(IVGEN.NE.0)GO TO 100
0183          WRITE(1,4414)
0184   4414   FORMAT ( "OBTAIN RESIDUAL CORRELATIONS" )
0185          DO 52 J=1,NV
0186          DO 52 I=J,NV
0187          SUM=0
0188          DO 51 K=1,NF
0189    51    SUM=SUM+F(I,K)*F(J,K)
0190          IF(I.NE.J)GO TO 53
0191          R(I,I)=SUM
0192          GO TO 52
0193    53    R(I,J)=R(J,I)-SUM
0194    52    CONTINUE
0195          KA=1
0196          KB=14
0197          IF(NV.LT.15)KB=NV
0198          LK=1
0199    50    WRITE(IUNIT,516)NF
0200          GO TO 60
0201    55    IF(KB.GE.NV)KB=NV
0202          IF(NV.GE.KA)GO TO 50
0203          WRITE(IUNIT,515)
0204   100    CONTINUE
0205          IF(IGEN.EQ.0)GO TO 200
0206          IGEN=0
0207          JG=1
0208          GO TO 10
0209   999    WRITE(IUNIT,517)NV,NVC,NE
0210   200    IF(JACK.EQ.1)GO TO 1545
0211          WRITE(1,4415)
0212   4415   FORMAT ( "ENTER 1 TO CONTINUE, 0 TO END RUN: ")
0213          READ(1,*)  ICOM
0214          IF(ICOM.EQ.1) GO TO 1
0215          STOP
0216          END
```

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```
0217          SUBROUTINE CROT(J,K)
0218          INTEGER VID
0219          COMMON R(30,30),H(30),VID(30,4),F(30,10),
0220         XAID(30,10),NI(25),NOM(48)
0221          COMMON NV,NF,CON,MX,FN
0222          A=0
0223          B=0
0224          C=0
0225          D=0
0226          DO 5 I=1,NV
0227          U=(F(I,J)+F(I,K))*(F(I,J)-F(I,K))
0228          V=2.*F(I,J)*F(I,K)
0229          A=A+U
0230          B=B+V
0231          C=C+(U*U-V*V)
0232    5     D=D+2.*U*V
0233          V=D-(2.*A*B)/FN
0234          U=C-(A*A-B*B)/FN
0235          IF(U.EQ.0)GO TO 84
0236          D=V/U
0237          D=ATAN(D)*CON
0238          IF(V)81,82,82
0239    81    IF(U)83,84,86
0240    82    IF(U)85,84,86
0241    83    V=D-180.
0242          GO TO 87
0243    84    IF(V.EQ.0)GO TO 90
0244          IF(V.LT.0)V=-90.
0245          IF(V.GT.0.)V=90
0246          GO TO 87
0247    85    V=180.+D
0248          GO TO 87
0249    86    V=D
0250    87    V=V/4.
0251          IF(ABS(V).GT..01)GO TO 91
0252    90    MX=MX-1
0253          GO TO 21
0254    91    V=V/CON
0255          A=SIN(V)
0256          B=COS(V)
0257          DO 20 I=1,NV
0258          D=F(I,J)*B+F(I,K)*A
0259          F(I,K)=-F(I,J)*A+F(I,K)*B
0260    20    F(I,J)=D
0261    21    CONTINUE
0262          RETURN
0263          END
0264          END$
```

III. NONPARAMETRIC STATISTICS

RANK   (Column Ranking)

Purpose:

This program ranks data in a data file and creates a new file to be stored on the disc.

Layout of Design:

Ranking is done across columns independently of rows. In the case of a tied observation average ranks are assigned.

User Considerations and Procedures:

1. RANK expects a data file to be created in a row x column (R x C) matrix form. A printout of raw data would show C (column) elements per line. The created file has the same data format and record length as the original.

2. The data analysis can either be displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. Program has four options for data printout. Enter:

    1 for printout of raw data only

    2 for raw and ranked data printout

    3 for ranked data printout

    4 for no printout

4. Parameters required:

    a. number of columns (maximum 100)

    b. number of rows (maximum 32767)

    c. raw data file name

    d. format and record length of data file

    e. new file name (not same as raw data file)

5. Printout as optioned for only.

Comments:

Ranked data are used for program CHIRA.

```
RU,RANK
ENTER NUMBER OF COLUMNS
8
ENTER NUMBER OF ROWS
32
ENTER DATA FILE NAME
#FATAA
ENTER DATA FORMAT

(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA30
64
ENTER OUTPUT FILE NAME
GEORGE
ENTER 1 FOR PRINTOUT OF ONLY RAW DATA, 2 FOR RAW DATA AND RANKED DATA,
  3 FOR ONLY RANKED DATA, AND 4 FOR NO PRINTOUT AT ALL
2
ENTER 1 FOR CRT DISPLAY, 6 FOR LPTR
6
:
```

RAW DATA

24.00	81.00	992.00	1024.0	978.00	1101.0	936.00	1120.0
25.00	22.00	181.00	310.00	293.00	346.00	188.00	166.00
27.00	57.00	124.00	172.00	166.00	491.00	154.00	83.00
29.00	36.00	553.00	719.00	605.00	833.00	585.00	346.00
30.00	54.00	1046.0	2221.0	1841.0	2656.0	1062.0	1030.0
31.00	25.00	322.00	522.00	402.00	676.00	261.00	379.00
32.00	78.00	838.00	364.00	222.00	433.00	1014.0	584.00
35.00	80.00	575.00	405.00	456.00	320.00	789.00	320.00
36.00	30.00	835.00	811.00	716.00	824.00	735.00	975.00
37.00	80.00	1001.0	166.00	179.00	154.00	907.00	1065.0
37.00	57.00	1418.0	1706.0	1656.0	1759.0	1024.0	219.00
45.00	74.00	531.00	503.00	581.00	593.00	481.00	593.00
77.00	66.00	218.00	637.00	681.00	591.00	300.00	201.00
80.00	47.00	133.00	109.00	112.00	106.00	166.00	108.00
80.00	80.00	74.00	100.00	115.00	90.00	79.00	68.00
80.00	74.00	550.00	322.00	422.00	204.00	600.00	400.00
18.00	61.00	72.00	429.00	456.00	411.00	405.00	856.00
19.00	18.00	67.00	760.00	356.00	509.00	966.00	3216.0
20.00	80.00	173.00	434.00	311.00	511.00	103.00	139.00
20.00	15.00	209.00	422.00	573.00	250.00	230.00	110.00
22.00	29.00	18.00	1024.0	1114.0	853.00	687.00	671.00
22.00	56.00	98.00	267.00	229.00	341.00	206.00	106.00
22.00	7.00	21.00	752.00	795.00	491.00	1252.0	1308.0
24.00	14.00	292.00	1312.0	1324.0	1296.0	1342.0	1851.0
80.00	51.00	116.00	777.00	1034.0	548.00	880.00	952.00
74.00	51.00	13.00	392.00	390.00	394.00	243.00	265.00
64.00	46.00	19.00	318.00	292.00	348.00	156.00	134.00
60.00	37.00	42.00	703.00	787.00	578.00	142.00	257.00
59.00	18.00	345.00	899.00	778.00	1141.0	424.00	411.00
54.00	14.00	49.00	968.00	747.00	1521.0	925.00	857.00
54.00	71.00	16.00	503.00	721.00	964.00	275.00	226.00
51.00	53.00	15.00	198.00	201.00	193.00	591.00	236.00

RANKED DATA

1.00	2.00	5.00	6.00	4.00	7.00	3.00	8.00
2.00	1.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
1.00	2.00	4.00	7.00	6.00	8.00	5.00	3.00
2.00	1.00	4.00	7.00	6.00	8.00	3.00	5.00
1.00	2.00	7.00	4.00	3.00	5.00	8.00	6.00
1.00	2.00	7.00	5.00	6.00	3.50	8.00	3.50
2.00	1.00	7.00	5.00	3.00	6.00	4.00	8.00
1.00	2.00	7.00	4.00	5.00	3.00	6.00	8.00
1.00	2.00	5.00	7.00	6.00	8.00	4.00	3.00
1.00	2.00	5.00	4.00	6.00	7.50	3.00	7.50
2.00	1.00	4.00	7.00	8.00	6.00	5.00	3.00
2.00	1.00	7.00	5.00	6.00	3.00	8.00	4.00
4.50	4.50	2.00	7.00	8.00	6.00	3.00	1.00
2.00	1.00	7.00	4.00	6.00	3.00	8.00	5.00

1.00	2.00	3.00	6.00	7.00	5.00	4.00	8.00
2.00	1.00	3.00	5.00	6.00	4.00	7.00	8.00
1.00	2.00	5.00	7.00	6.00	8.00	3.00	4.00
2.00	1.00	4.00	7.00	8.00	6.00	5.00	3.00
2.00	3.00	1.00	7.00	8.00	6.00	5.00	4.00
1.00	2.00	3.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	5.00	6.00	4.00	7.00	8.00
2.00	1.00	3.00	5.00	6.00	4.00	7.00	8.00
2.00	1.00	3.00	5.00	8.00	4.00	6.00	7.00
3.00	2.00	1.00	7.00	6.00	8.00	4.00	5.00
3.00	2.00	1.00	7.00	6.00	8.00	5.00	4.00
3.0）	1.00	2.00	7.00	8.00	6.00	4.00	5.00
2.00	1.00	3.00	7.00	6.00	8.00	5.00	4.00
3.00	1.00	2.00	7.00	4.00	8.00	6.00	5.00
2.00	3.00	1.00	7.00	6.00	8.00	5.00	4.00
2.00	3.00	1.00	5.00	6.00	4.00	8.00	7.00

```
0001   FTN4
0002          PROGRAM RANK
0003          COMMON A(100),A1(100),NAME(3),IFMT(20)
0004          COMMON IB(272),IC(272),IBUF(256),ISIZE(2)
0005          DO 109 I=1,100
0006          A(I)=0.
0007          A1(I)=0.
0008   109    CONTINUE
0009          WRITE(1,17)
0010   17     FORMAT(" ENTER NUMBER OF COLUMNS ")
0011          READ(1,*) NC
0012          WRITE(1,16)
0013   16     FORMAT(" ENTER NUMBER OF ROWS")
0014          READ(1,*) NR
0015          WRITE(1,15)
0016   15     FORMAT(" ENTER DATA FILENAME")
0017          READ(',1) NAME
0018   1      FORMAT(3A2)
0019          WRITE(1,14)
0020   14     FORMAT(" ENTER DATA FORMAT")
0021          READ(1,11)IFMT
0022   11     FORMAT(20A2)
0023          WRITE(1,88)
0024   88     FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0025          READ(1,*) LENGTH
0026          LEN=LENGTH/2
0027          IF((LEN*2).NE.LENGTH) LEN=LEN+1
0028          LENGTH=LEN
0029          IDCBS=LENGTH
0030          IF(LENGTH.LT.144) IDCBS=144
0031          CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0032          IF(IER.GE. 0) GO TO 543
0033          WRITE(1,566) NAME,IER
0034   566    FORMAT(5X,3A2," FAILED TO OPEN ,  IER = ",I5)
0035          STOP 566
0036   543    WRITE(1,12)
0037   12     FORMAT(" ENTER OUTPUT FILENAME")
0038          READ(1,1)NAME
0039          ISIZE(2)=LENGTH
0040          SIZE=LENGTH
0041          XSU=NR
0042          SIZE=XSU*SIZE/128. + 1.
0043          ISIZE(1)=SIZE
0044          CALL CREAT(IC,IER,NAME,ISIZE,2,0,-2,IDCBS)
0045          IF(IER.GE.0) GO TO 350
0046          WRITE(1,566) NAME,IER
0047          STOP 567
0048   350    DO 100 M5=1,NR
0049          L1=1
0050          N=0
0051          CALL READF(IB,IER,IBUF)
0052          CALL CODE
```

```
0053          READ(IBUF,IFMT)(A(K),K=1,NC)
0054    2     ALOW=9999.99
0055          N=N+L1
0056          DO 3 K=1,NC
0057          IF(A(K).EQ.9999.99)GO TO 3
0058          IF(A(K).LT.ALOW)ALOW=A(K)
0059    3     CONTINUE
0060          IF(ALOW.EQ.9999.99)GO TO 10
0061          L1=0
0062          C=0
0063          DO 5 K=1,NC
0064          IF(A(K).NE.ALOW)GO TO 5
0065          L1=L1+1
0066          C=C+N+L1-1
0067    5     CONTINUE
0068          C=C/L1
0069          DO 4 K=1,NC
0070          IF(A(K).NE.ALOW)GO TO 4
0071          A1(K)=C
0072          A(K)=9999.99
0073    4     CONTINUE
0074          GO TO 2
0075    10    CALL CODE
0076          WRITE(IBUF,IFMT)(A1(K),K=1,NC)
0077          CALL WRITF(IC,IER,IBUF)
0078    100   CONTINUE
0079          WRITE(1,159)
0080    159   FORMAT("ENTER 1 FOR PRINTOUT OF ONLY RAW DATA,2 FOR RAW DATA ",
0081          $/,"  AND RANKED DATA,3 FOR ONLY RANKED DATA , AND 4 FOR NO ",/
0082          $,"PRINTOUT AT ALL")
0083          READ(1,*) IPTO
0084          IF((IPTO.LT.1).OR.(IPTO.GE.4)) GO TO 32
0085          WRITE(1,160)
0086    160   FORMAT("ENTER 1 FOR CRT DISPLAY, 6 FOR LPTR")
0087          READ(1,*) IUNIT
0088          CALL RWNDF(I9)
0089          CALL RWNDF(IC)
0090          IF(IPTO.EQ.3) GO TO 788
0091          WRITE(IUNIT,209)
0092    209   FORMAT(//,5X,"RAW DATA",//)
0093          DO 137 I=1,NR
0094          CALL READF(I8,IER,IBUF)
0095          CALL CODE
0096          READ(IBUF,IFMT) (A(K),K=1,NC)
0097    137   WRITE(IUNIT,IFMT) (A(K),K=1,NC)
0098          IF(IPTO.EQ.1)  GO TO 32
0099    788   WRITE(IUNIT,237)
0100    237   FORMAT(///,5X,"RANKED DATA "/)
0101          DO 273 I=1,NR
0102          CALL READF(IC,IER,IBUF)
0103          CALL CODE
0104          READ(IBUF,IFMT) (A1(K),K=1,NC)
0105    273   WRITE(IUNIT,391) (A1(K),K=1,NC)
0106    391   FORMAT(10(1X,F6.2))
0107    32    CALL CLOSE (I8,IER)
0108          CALL CLOSE (IC,IER)
0109          END
0110          END$
```

ORANK   (Matrix Ranking)

Purpose:

> This program ranks data in a data file and creates a new file to be stored on disc.

Layout of Design:

> Unlike the program RANK, ranking is done for entire data set. In case of tied observations, ranks are assigned randomly.

User Considerations and Procedures:

1. Program expects data file to be created in a row x column (R x C) matrix format. A printout of raw data would have C (column) elements per line. The created data file would be in R x C matrix form with different data format and record length.

2. Parameters required:

   a. raw data file name

   b. ranked data file name

   c. raw data format and record length

   d. ranked data format and record length

   e. number of records (rows) (see comments)

   f. number of columns (see comments)

3. There is no printout of the ranked data.

Comments:

> The maximum size of parameters, row (R) and column (C), is as follows:

1. $C \leqslant 30$

2. $R * C \leqslant 2500$

```
 RU,ORANK
PROGRAM TO RANK ENTIRE DATA SET BY ROWS AND COLUMNS
ENTER NAME OF INPUT DATA FILE
#FATAA
ENTER NAME OF OUTPUT DATA FILE
#UWF
ENTER INPUT DATA FILE FORMAT
(8(2X,F6.2))
ENTER OUTPUT DATA FILE FORMAT
(8(2X,F6.2))
 ENTER THE RECORD LENGTH AS IN DA30
64
 ENTER THE OUTPUT RECORD LENGTH AS IN DA30
64
 ENTER IN NUMBER OF RECORDS
32
 ENTER IN NUMBER OF VARIABLES
8
  ^RANK  :  STOP    0000
:LL,6
:LI,#FATAA,A
:LI,#UWF,A
:
```

```
0001    FTN4,L
0002            PROGRAM ORANK
0003            COMMON Y(2500),IB(272),IC(272),IBUF(256),ICUF(256),NAME(3),
0004           &INAME(3),IFMT(20),IFMT2(20),X(30),JJ(30),IREC,IVAR,ISIZE(2)
0005            COMMON Z(30)
0006            WRITE(1,1)
0007    1       FORMAT("PROGRAM TO RANK ENTIRE DATA SET BY  ROWS AND COLUMNS")
0008            WRITE(1,2)
0009    2       FORMAT("ENTER NAME OF INPUT DATA FILE")
0010            READ(1,3) NAME
0011    3       FORMAT(3A2)
0012            WRITE(1,4)
0013    4       FORMAT("ENTER NAME OF OUTPUT DATA FILE")
0014            READ(1,3) INAME
0015            WRITE(1,5)
0016    5       FORMAT("ENTER INPUT DATA FILE FORMAT")
0017            READ(1,6) IFMT
0018    6       FORMAT(20A2)
0019            WRITE(1,7)
0020    7       FORMAT("ENTER OUTPUT DATA FILE FORMAT")
0021            READ(1,6) IFMT2
0022            WRITE(1,88)
0023    88      FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0024            READ(1,*) LENGTH
0025            LEN=LENGTH/2
0026            IF((LEN*2).NE.LENGTH) LEN=LEN+1
0027            LENGTH=LEN
0028            IDCBS=LENGTH
0029            IF(LENGTH.LT.144) IDCBS=144
0030            CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0031            IF(IER.GT.0) GO TO 8
0032            WRITE(1,9) NAME,IER
0033    9       FORMAT(3A2," FAILED TO OPEN , IER = ",I5)
0034            STOP 1
0035    8       CONTINUE
0036            WRITE(1,89)
0037    89      FORMAT(" ENTER THE OUTPUT RECORD LENGTH AS IN DA30")
0038            READ(1,*) LENGTH
0039            LEN=LENGTH/2
0040            IF((LEN*2).NE.LENGTH) LEN=LEN+1
0041            LENGTH=LEN
0042            IDCBS=LENGTH
0043            IF(LENGTH.LT.144) IDCBS=144
0044            WRITE(1,10)
0045    10      FORMAT("ENTER IN NUMBER OF RECORDS")
0046            READ(1,*) IREC
0047            WRITE(1,11)
0048    11      FORMAT("ENTER IN NUMBER OF VARIABLES")
0049            READ(1,*) IVAR
0050            ITOTAL=IREC*IVAR
```

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```
0051          SIZE=LENGTH
0052          ISIZE(2)=LENGTH
0053          XG=IREC
0054          SIZE=XG*SIZE/128. + 1
0055          ISIZE(1)=SIZE
0056          CALL CREAT(IC,IER,INAME,ISIZE,2,0,-2,IDCBS)
0057          IF(IER.LT.0) WRITE(1,9) INAME,IER
0058          IF(IER.LT.0) CALL CLOSE(IB)
0059          IF(IER.LT.0) STOP
0060          DO 12 J=1,IREC
0061          CALL READF(IB,IER,IBUF)
0062          CALL CODE
0063          READ(IBUF,IFMT)(X(I),I=1,IVAR)
0064          DO 13 I=1,IVAR
0065          L=(J-1)*IVAR+I
0066     13   Y(L)=X(I)
0067     12   CONTINUE
0068          CALL SORT(ITOTAL)
0069          CALL RWNDF(IB)
0070          DO 50 K=1,IREC
0071          CALL READF(IB,IER,IBUF)
0072          CALL CODE
0073          READ(IBUF,IFMT) (X(I3),I3=1,IVAR)
0074          DO 51 J=1,IVAR
0075          DO 52 I=1,ITOTAL
0076          IF(X(J).NE.Y(I)) GO TO 52
0077          Y(I)=-9J9.363
0078          Z(J)=I
0079          GO TO 51
0080     52   CONTINUE
0081     51   CONTINUE
0082          CALL CODE
0083          WRITE(ICUF,IFMT2) (Z(I4),I4=1,IVAR)
0084          CALL WRITF(IC,IER,ICUF)
0085     50   CONTINUE
0086     26   CALL CLOSE(IB)
0087          CALL CLOSE(IC)
0088          STOP
0089          END
0090          SUBROUTINE SORT(N)
0091          COMMON Y(2500)
0092          N1=N-1
0093          DO 1 I=1,N1
0094          J=1+I
0095          DO 2 K=J,N
0096          IF(Y(I).LE.Y(K)) GO TO 2
0097          TEMP=Y(I)
0098          Y(I)=Y(K)
0099          Y(K)=TEMP
0100      2   CONTINUE
0101      1   CONTINUE
0102          END
0103          END*
```

STACH   (Nonparametric Descriptive Statistics)

Purpose:

This program is a descriptive package for nonparametric data
which includes the following statistics: mean, median, standard
deviation, middle 80 percentile range, semi-interquartile range,
alpha 3, and alpha 4. This program also performs a chi-squared
goodness of fit test for testing normality based on a frequency
histogram of the raw data.

Mathematical Model:

The program creates a histogram, with a specified number of classes,
from the raw data. Then, it standardizes each variable by the mean
and variance of the histogram. The chi-squared value is determined
by comparison of the histogram class frequency against the expected
standard normal class frequency. This is done by:

$$Chi^2 = \sum_{i=1}^{N} \left[\frac{(f_i - E(f_i))^2}{E(f_i)} \right]$$

where:

f_i = actual frequency

$E(f_i)$ = expected frequency

N = number of classes

User Considerations and Procedures:

1.   Program expects data created in matrix form. Each record con-
     tains X_{ij}; $j = 1$, M; where M = number of variables in data set;
     and i = the observation (or subject number). A printout of raw
     data would show m data points per line.

2.   The data analysis can be either displayed on the CRT or hardcopy
     can be obtained from the line printer. Option: 1 for CRT output,
     6 for line printer output.

3.   A printout of the raw data can be obtained. Option: 1 if raw
     data printout is desired, 0 for no printout. The output device
     is designated by the above option (#2).

4.   A printout of the histogram can be obtained. Enter 1 if a histo-
     gram printout is desired, 0 for no printout.

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5. Program asked if test for normality is wanted. Respond 1 for yes. If only the histogram and/or different nonparametric statistics are desired, respond 0.

6. An option for IAP (rerun program) exists, respond 1 if you wish to rerun program, 0 for no.

7. A printout if the expected normal frequencies can be obtained. Enter 1 if desired, 0 if not.

8. Parameters required:

    a. number of variables in data file (maximum 100)

    b. number of subjects (maximum 32767)

    c. number of classes in histogram (maximum 25)

    d. number of variables to be analyzed (maximum 100)

    e. enter variable numbers which are to be analyzed

    f. name of data file

    g. format and record length of data file (see DA30)

9. Printout gives:

    a. number of observations, mean, median, mode, standard deviation, middle 80 percent range, semi-interquartile range, alpha 3, alpha 4, for each requested variable

    b. frequency histogram (optional)

    c. expected normal frequency (optional)

    d. chi-squared value and degrees of freedom (optional)

Comments:

The results of the chi-squared test gives the calculated chi-squared value with its degrees of freedom. To determine the probability level go to a chi-squared table. This test is very conservative; data have to be very unnormal to reject null hypothesis.

Test Data:

The data used to test this program is the same as SRM30 (See SRM30). This program was hand-tested using a Texas Instrument calculator software program. The program uses double precision for most variables.

```
 RU,STACH
ENTER NUMBER OF VARIABLES
8
ENTER THE NUMBER OF VARIABLES TO BE ANALYZED
1
ENTER NUMBER OF SUBJECTS
64
ENTER # OF CLASSES IN THE POLYGON; MAX=25
8
POLYGON WANTED?  1=YES, Ø=NO
1
TEST FOR NORMALITY WANTED?  1=YES, Ø=NO
1
   IAP    1=YES,  Ø = NO
Ø
ENTER DATA FILE NAME
#STACH
ENTER DATA FORMAT
(8(2X,F6.2))
ENTER THE RECORD LENGTH AS IN DA3Ø
64
ENTER 1 FOR CRT OUTPUT, 6 FOR LP
6
ENTER NUMBER OF VARIABLES TO BE INCLUDED
1
ENTER 1 FOR RAW DATA PRINTOUT
Ø
ENTER 1 FOR PRINTOUT OF EXPECTED VALUES
1
:
```

```
STATISTICS FOR VARIABLE               1
NUMBER  =                            64
MEAN  =                          42.750
MEDIAN  =                        35.500
MODE  =                          25.500
STANDARD DEVIATION  =            21.034
MIDDLE 80 PCT RANGE  =           57.173
SEMI INTERQUARTILE RANGE  =      18.133
ALPHA 3  =                         .561
ALPHA 4  =                        1.813


FREQUENCY POLYGON VARIABLE            1
17.500    25.500    XXXXXXXXXXXXXXXXXXXX
25.500    33.500    XXXXXXXXXX
33.500    41.500    XXXXXXXXX
41.500    49.500    XX
49.500    57.500    XXXXXX
57.500    65.500    XXXXXX
65.500    73.500
73.500    81.500    XXXXXXXXXXX

EXPECTED NORMAL VALUES
       13.1892185
        7.9343309
        9.3600349
        9.5714035
        8.4840889
        6.5187569
        4.3416157
        4.6005507

VARIABLE   1   CHI SQUARED FOR NORMALITY   =   12.056,DF = 6
  CK    3
  CK    4
  CK    5
```

```
0001   FTN4
0002        PROGRAM STACH
0003        DOUBLE PRECISION Z1,T1,V(25)
0004        COMMON SC(100),IBUF(256),IB(272),NJ(2),NAME(3),IFMT(20),
0005   CNUL(100)
0006   $,LINE(100),FR(25),VLL(25),V,THE(25)
0007        INTEGER BLANK,EX
0008        DATA BLANK/2H  /,EX/2HX /
0009   101  CONTINUE
0010        WRITE(1,395)
0011   395  FORMAT("ENTER NUMBER OF VARIABLES")
0012        READ(1,*) NV
0013        WRITE(1,298)
0014   298  FORMAT("ENTER THE NUMBER OF VARIABLES TO BE ANALYIZED")
0015        READ(1,*) NW
0016        WRITE(1,299)
0017   299  FORMAT("ENTER NUMBER OF SUBJECTS")
0018        READ(1,*) NP
0019        WRITE(1,330)
0020   330  FORMAT("ENTER # OF CLASSES IN THE POLYGON ; MAX=25")
0021        READ(1,*) NC
0022        WRITE(1,332)
0023   332  FORMAT("POLYGON WANTED ? 1 = YES  0=NO")
0024        READ(1,*) NJ(1)
0025        WRITE(1,331)
0026   331  FORMAT("TEST FOR NORMALITY WANTED ? 1=YES  0=NO")
0027        READ(1,*) NJ(2)
0028        WRITE(1,334)
0029   334  FORMAT("  IAP    1=YES   0=NO")
0030        READ(1,*) IAP
0031        WRITE(1,333)
0032   333  FORMAT("ENTER DATA FILE NAME")
0033        READ(1,1002) NAME
0034   1002 FORMAT(3A2)
0035        WRITE(1,1003)
0036   1003 FORMAT("ENTER DATA FORMAT")
0037        READ(1,1004) IFMT
0038   1004 FORMAT(20A2)
0039        WRITE(1,88)
0040   88   FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0041        READ(1,*) LENGTH
0042        LEN=LENGTH/2
0043        IF((LEN*2).NE.LENGTH) LEN=LEN+1
0044        LENGTH=LEN
0045        IDCBS=LENGTH
0046        IF(LENGTH.LT.144) IDCBS=144
0047        CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0048        IF(IER.GE.0) GO TO 73
0049        WRITE(1,39) NAME,IER
0050   39   FORMAT(3A2," FAILED TO OPEN , IER = ",I3)
```

```
0051          STOP
0052    73    WRITE(1,98)
0053    98    FORMAT("ENTER 1 FOR CRT OUTPUT, 6 FOR LP")
0054          READ(1,*) IUNIT
0055          WRITE(1,934)
0056    934   FORMAT("ENTER NUMBER OF VARIALBES TO BE INCLUDED")
0057          READ(1,*) (NWL(I),I=1,NW)
0058          WRITE(1,437)
0059    437   FORMAT("ENTER 1 FOR RAW DATA PRINTOUT")
0060          READ(1,*) IPTO
0061          WRITE(1,3487)
0062    3487  FORMAT("ENTER 1 FOR PRINTOUT OF EXPECTED VALUES")
0063          READ(1,*) ITP
0064          DO 231 I31=1,NW
0065          SUMX=0.
0066          SUMX2=0.
0067          DO 4 I=1,NP
0068          CALL READF(IB,IER,IBUF)
0069          CALL CODE
0070          READ(IBUF,IFMT) (SC(J),J=1,NV)
0071          IF (IPTO.EQ.1) WRITE(IUNIT,IFMT) (SC(J),J=1,NV)
0072          X=SC(NWL(I31))
0073          SUMX=SUMX+X
0074          SUMX2=SUMX2+X*X
0075          IF(I.NE.1)GO TO 400
0076          XL=X
0077          XH=X
0078    400   IF(X.LT.XL) XL=X
0079          IF(X.GT.XH) XH=X
0080    4     CONTINUE
0081          SNC=NC
0082          IPTO=0
0083          SNP=NP
0084          RINC=XH-XL+1
0085          CI=RINC/SNC
0086          NCI=CI+.99999
0087          CI=NCI
0088          DO 7 K=1,NC
0089    7     FR(K)=0
0090          DO 8 K=1,NC
0091          FK=K
0092    8     YLL(K)=XL-.5+(FK-1)*CI
0093          CALL RWNDF(IB)
0094          DO 9 I=1,NP
0095          CALL READF(IB,IER,IBUF)
0096          CALL CODE
0097          READ(IBUF,IFMT)(SC(J),J=1,NV)
0098          XC=SC(NWL(I31))
0099          KK=(XC-YLL(1))/CI+1
0100    10    FR(KK)=FR(KK)+1
0101    9     CONTINUE
```

```
0102          COD1=.1*SNP
0103          COQ1=.25*SNP
0104          COD5=.5*SNP
0105          COQ3=.75*SNP
0106          COD9=.9*SNP
0107          SX=0
0108          SSX=0
0109          SCX=0
0110          SQX=0
0111          DO 12 J=1,NC
0112          SNC=J
0113          AA=VLL(1)+CI*(SNC-.5)
0114          SX=SX+FR(J)*AA
0115          SSX=SSX+FR(J)*(AA**2)
0116          SCX=SCX+FR(J)*(AA**3)
0117    12    SQX=SQX+FR(J)*(AA**4)
0118          CTM=SX/SNP
0119          SIG=SQRT(SNP*SSX-SX**2)/SNP
0120          ALPH=SCX-3*CTM*SSX+2*SNP*(CTM**3)
0121          ALPH=ALPH/(SNP*(SIG**3))
0122          BET=SQX-4*SCX*CTM+6*SSX*(CTM**2)-3*SNP*(CTM**4)
0123          BET=BET/(SNP*(SIG**4))
0124          AA=0
0125          DO 14 J=1,NC
0126          BB=AA+FR(J)
0127          IF(BB.GE.COD1)GO TO 15
0128          AA=BB
0129          GO TO 14
0130    15    DE1=VLL(J)+CI*(COD1-AA)/FR(J)
0131          GO TO 16
0132    14    CONTINUE
0133    16    AA=0
0134          WRITE(IUNIT,663)
0135   663    FORMAT("  CK   3    ")
0136          DO 17 J=1,NC
0137          BB=AA+FR(J)
0138          IF(BB.GE.COQ1)GO TO 18
0139          AA=BB
0140          GO TO 17
0141    18    QT1=VLL(J)+CI*(COQ1-AA)/FR(J)
0142          GO TO 19
0143    17    CONTINUE
0144    19    AA=0
0145          DO 20 J=1,NC
0146          BB=AA+FR(J)
0147          IF(BB.GE.COD5)GO TO 21
0148          AA=BB
0149          GO TO 20
0150    21    DE5=VLL(J)+CI*(COD5-AA)/FR(J)
0151          GO TO 22
0152    20    CONTINUE
0153    22    AA=0
0154          DO 23 J=1,NC
0155          BB=AA+FR(J)
0156          IF(BB.GE.COQ3) GO TO 24
```

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```
0157        AA=BB
0158        GO TO 23
0159   24   QT3=VLL(J)+CI*(COQ3-AA)/FR(J)
0160        GO TO 25
0161   23   CONTINUE
0162   25   AA=0
0163        WRITE(IUNIT,664)
0164   664  FORMAT("   CK  4    ")
0165        DO 26 J=1,NC
0166        BB=AA+FR(J)
0167        IF(BB.GE.COD9)GO TO 27
0168        AA=BB
0169        GO TO 26
0170   27   DE9=VLL(J)+CI*(COD9-AA)/FR(J)
0171        GO TO 28
0172   26   CONTINUE
0173   28   RM80=DE9-DE1
0174        SIQ=(QT3-QT1)/2
0175        AA=FR(1)
0176        NX=1
0177        DO 29 J=1,NC
0178        IF(FR(J).GT.AA)NX=J
0179        IF(FR(J).GT.AA)AA=FR(J)
0180   29   CONTINUE
0181        WRITE(IUNIT,667)
0182   667  FORMAT("   CK  5   ")
0183        NNX=NX+1
0184        NMX=NX-1
0185        RAT=(FR(NNX))/(FR(NNX)+FR(NMX))
0186        VMOD=VLL(NX)+RAT*CI
0187        I9=IUNIT
0188        WRITE(I9,30)I31,NP,CTM,DE5,VMOD,SIG,RM80,SIQ,ALPH,BET
0189   30   FORMAT(1H1,"STATISTICS FOR VARIABLE",I3/1X,"NUMBER  =",I4/
0190       X1X,"MEAN  =",F7.3/1X,"MEDIAN=",F7.3/1X,"MODE  =",F7.3/1X,
0191       X"STANDARD DEVIATION  =",F7.3/1X,"MIDDLE 80 PCT RANGE  ",
0192       XF7.3/1X,
0193       X"SEMI INTERQUARTILE RANGE  =",F7.3/1X,"ALPHA 3  =",F7.3/1X,
0194       X"ALPHA 4  =",F7.3)
0195        IF(NJ(1).EQ.0)GO TO 200
0196        WRITE(IUNIT,31)I31
0197   31   FORMAT(1H1,"FREQUENCY POLYGON VARIABLE  ",I3)
0198        DO 32 J=1,NC
0199        DO 33 K=1,100
0200   33   LINE(K)=BLANK
0201        NBAR=FR(J)
0202        IF(NBAR.EQ.0)GO TO 100
0203        DO 34 K=1,NBAR
0204   34   LINE(K)=EX
0205   100  HL=VLL(J)+CI
0206        WRITE(IUNIT,35)VLL(J),HL,(LINE(K),K=1,100)
0207   35   FORMAT(1H0,F7.3,1H ,F7.3,2X,100A1)
0208   32   CONTINUE
0209   200  IF(NJ(2).EQ.0)GO TO 11
```

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```
0210          CHI=0
0211   C      SIG=SQRT((SUMX2-SUMX*SUMX/SNP)/(SNP-1.))
0212   C      CTM=SUMX/SNP
0213          DO 93 IJ=1,NC
0214          Z1=(VLL(IJ)-CTM)/SIG
0215          CALL YNORM(Z1,T1)
0216   93     V(IJ)=T1
0217          NCC=NC-1
0218          THE(1)=SNP*V(2)
0219          DO 733 IV=2,NCC
0220          J3=IV+1
0221   733    THE(IV)=SNP*DABS(V(J3)-V(IV))
0222   734    FORMAT(5X,F14.7)
0223          THE(NC)=SNP*DABS(1-V(NC))
0224          IF(ITP.EQ.1) WRITE(IUNIT,9812)
0225   9812   FORMAT(" EXPECTED NORMAL VALUES ",5X,F14.7)
0226          IF(ITP.EQ.1) WRITE(IUNIT,734) (THE(IK),IK=1,NC)
0227          DO 248 J=1,NC
0228          IF(J.EQ.NC)GO TO 40
0229          IF(THE(J).GE.5)GO TO 40
0230          K=J+1
0231          NCC=NCC-1
0232          THE(K)=THE(J)+THE(K)
0233          FR(K)=FR(K)+FR(J)
0234          GO TO 248
0235   40     CHI=CHI+((FR(J)-THE(J))**2)/THE(J)
0236   248    CONTINUE
0237          WRITE(IUNIT,41)I31,CHI,NCC
0238   41     FORMAT(1H0/1X,"VARIABLE",I3," CHI SQUARED FOR NORMALITY=",F7.3,
0239         X",DF=",I3)
0240   11     CONTINUE
0241   231    CALL RWNDF(IB)
0242          CALL CLOSE(IB)
0243          IF(IAP.EQ.1) GO TO 101
0244          END
0245          END$
```

CHIRA   (Coefficient of Concordance)

Purpose:

This program finds Kendall's coefficient of concordance, W, tests for its significance, and provides reliability figures of the ranked data. Wilcoxin sign rank, Z, can also be obtained for all variable combinations.

Mathematical Model and Layout of Design:

In our layout, we have N objects (or individuals) ranked in K-sets. Each set is ranked independently of each other.

$$
\begin{array}{c|cccccc}
 & 1 & 2 & 3 & . & . & . & N \\
\hline
1 & r_{11} & r_{12} & r_{13} & . & . & . & r_{1n} \\
2 & r_{21} & r_{22} & r_{23} & . & . & . & r_{2n} \\
3 & r_{31} & r_{32} & r_{33} & . & . & . & r_{3n} \\
. & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . \\
. & . & . & . & . & . & . & . \\
k & r_{k1} & r_{k2} & r_{k3} & & & & r_{kn} \\
\end{array}
$$

1. Mount a magnetic tape! (any scratch tape will do).

2. Program expects ranked data in k x N matrix form to have been created (see program RANK). A printout of data would show N observations per line.

3. The data analysis can be either displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

4. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#3).

5. Program asks if Wilkoxin sign rank, Z, is desired. Enter 1 for yes, 0 for no. NOTE: The program prints out the Wilcoxin Z for all pairs of variables and an approximate probability. The number of signed ranks = $N(N-1)/2$.

6. Parameters required:

    a. number of columns = N = (maximum 70)

    b. number of rows = k = (maximum 30)

    c. enter 1 for correction of ties (Not to correct for ties is incorrect! If data have been created using RANK, ties have already been assigned average ranks.)

    d. name of ranked data file

    e. format and record length of data file (see DA30)

7. Printout gives:

    a. raw data (optional)

    b. Wilkoxin $\bar{Z}$ (optional)

    c. Kendall's W, chi-square with degrees of freedom, average row reliability, and total reliability

    d. $\underline{S}$, sum of squared deviations from mean of nth object (see comments)

Comments:

The hypothesis being tested with Kendall's W is whether k-sets of rankings are independent. Kendall's W expresses the degree of agreement among the k-sets (judges, etc.) in ranking the N objects. When $N > 7$, W is related to the chi-squared distribution by

$$X^2 = k(N - 1)W \text{ with } df = N - 1.$$

The program gives the X^2 value in all cases. If $N \leqslant 7$ this value will be incorrect. For critical values in this case ($N \leqslant 7$) see S. Siegel, Nonparametric Statistics for the Behavioral Sciences, Table R, P. 286. This table gives critical values of $\underline{S}$, which the program prints out. The table shows minimum critical values of $\underline{S}$ for the .05 and .01 level of significance.

If $N > 7$, compare the chi-square for R, printed by program, with the chi-square value from any table of critical values (i.e., Table C, P. 249, in S. Siegel).

The average row reliability equals (kW - 1)/(W (k - 1)). Total
reliability equals (kW -1)/(W (k - 1)).

In Wilcoxin Z, the hypothesis we are testing is whether 2 variables
(in each Z) differ.

Test Data:

This program was tested using data from S. Siegel, Nonparametric
Statistics for the Behavioral Sciences, McGraw-Hill, 1956, P. 233-237.

```
 RU,CHIRA
ENTER DATA FILE NAME
#CHIRA
 DO YOU WISH TO COMPUTE WITH TIES   1=YES, 0=NO
1
 NUMBER OF COLUMNS (MAX 70) :
4
 NUMBER OF ROWS (MAX 30):
10
 ENTER DATA FORMAT
(4(1X,F3.0))
 ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT
6
ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0
1
DO YOU WANT WILKOXIN SIGN RANK Z?, 1=YES, 0=NO
1
 ENTER  THE RECORD LENGTH AS IN DA30
16
CHIR  :  STOP     0000
CTAPE ABORTED
:
```

RAW DATA

1.0000	2.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
2.0000	1.0000	3.0000	4.0000
2.0000	1.0000	3.0000	4.0000
1.0000	2.0000	3.0000	4.0000
1.0000	3.0000	2.0000	4.0000
1.0000	2.0000	3.0000	4.0000
2.0000	1.0000	4.0000	3.0000
1.0000	2.0000	4.0000	3.0000

DATA CALCULATED WITH CORRECTIONS FOR TIES
CHI SQUARE FOR R = 23.880, DEGREES OF FREEDOM = 3
KENDALL'S W = .796
AVERAGE ROW RELIABILITY = .773 TOTAL RELIABILITY = .972

8 = 398.00000

VAR 1 AND VAR 2   WILCOXIN SIGNED RANK Z = -1.274   # OF PAIRS = 10 ALPHA LEVEL SIGNIFICANCE = .50

VAR 1 AND VAR 3   WILCOXIN SIGNED RANK Z = -2.803   # OF PAIRS = 10 ALPHA LEVEL SIGNIFICANCE = .01

VAR 1 AND VAR 4   WILCOXIN SIGNED RANK Z = -2.803   # OF PAIRS = 10 ALPHA LEVEL SIGNIFICANCE = .01

VAR 2 AND VAR 3   WILCOXIN SIGNED RANK Z = -2.446   # OF PAIRS = 10 ALPHA LEVEL SIGNIFICANCE = .02

VAR 2 AND VAR 4   WILCOXIN SIGNED RANK Z = -2.803   # OF PAIRS = 10 ALPHA LEVEL SIGNIFICANCE = .01

VAR 3 AND VAR 4   WILCO   IGNED RANK Z = -1.784   # OF PAIRS = 10 ALPHA LEVEL SIGNIFICANCE = .50

```
CHIRA   T=00004 IS ON CR00002 USING 00001 BLKS R=0005

0001     :SV,4
0002     :RP,CTAPE
0003     :RU,CHIR
0004     :OF,CTAPE
0005     :SV,0
```

```
0001   FTN4
0002          PROGRAM CHIR
0003          COMMON SC(30,70),RS(70),D(30),DR(30),RA(30,70)
0004          DIMENSION TAB(25,3),IFMT(20),ITAPE(3)
0005          DATA ITAPE/2HCT,2HAP,2HE /
0006          DATA TAB(6,1),TAB(6,2),TAB(6,3)/2.227,99.999,99.999/
0007          DATA TAB(7,1),TAB(7,2),TAB(7,3)/2.028,2.366,99.999/
0008          DATA TAB(8,1),TAB(8,2),TAB(8,3)/1.960,2.240,2.521/
0009          DATA TAB(9,1),TAB(9,2),TAB(9,3)/1.955,2.310,2.429/
0010          DATA TAB(10,1),TAB(10,2),TAB(10,3)/1.988,2.293,2.497/
0011          DATA TAB(11,1),TAB(11,2),TAB(11,3)/1.956,2.312,2.490/
0012          DATA TAB(12,1),TAB(12,2),TAB(12,3,/1.961,2.275,2.510/
0013          DATA TAB(13,1),TAB(13,2),TAB(13,3)/1.992,2.271,2.481/
0014          DATA TAB(14,1),TAB(14,2),TAB(14,3)/1.977,2.291,2.480/
0015          DATA TAB(15,1),TAB(15,2),TAB(15,3)/1.988,2.272,2.499/
0016          DATA TAB(16,1),TAB(16,2),TAB(16,3)/1.965,2.275,2.482/
0017          DATA TAB(17,1),TAB(17,2),TAB(17,3)/1.965,2.296,2.533/
0018          DATA TAB(18,1),TAB(18,2),TAB(18,3)/1.982,2.286,2.504/
0019          DATA TAB(19,1),TAB(19,2),TAB(19,3)/1.972,2.294,2.535/
0020          DATA TAB(20,1),TAB(20,2),TAB(20,3)/1.979,2.315,2.501/
0021          DATA TAB(21,1),TAB(21,2),TAB(21,3)/1.964,2.311,2.520/
0022          DATA TAB(22,1),TAB(22,2),TAB(22,3)/1.964,2.289,2.516/
0023          DATA TAB(23,1),TAB(23,2),TAB(23,3)/1.977,2.312,2.524/
0024          DATA TAB(24,1),TAB(24,2),TAB(24,3)/1.971,2.314,2.543/
0025          DATA TAB(25,1),TAB(25,2),TAB(25,3)/1.978,2.301,2.543/
0026   50     REWIND 8
0027   173    S=0
0028          CALL EXEC(9,ITAPE)
0029          REWIND 8
0030          READ(8,239) IER,ICON
0031          IF (IER.LT.0) GO TO 333
0032   239    FORMAT(2I5)
0033          READ(8,2031) ITIES,NK,NR,IUNIT
0034   2031   FORMAT(4I5)
0035          READ(8,2033) IFMT
0036   2033   FORMAT(20A2)
0037          DO 70 I=1,70
0038   70     RS(I)=0
0039          DO 71 I=1,30
0040          DR(I)=0.
0041   71     D(I)=0
0042          SUM=0
0043          T=0
0044          DO 2 I=1,NR
0045          READ(8,IFMT) (SC(I,J),J=1,NK)
0046   2      CONTINUE
0047          DO 4 I=1,NR
0048          DO 4 J=1,NK
0049          RA(I,J)=.5
0050          DO 4 K=1,NK
```

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```
0051          IF(SC(I,J).EQ.SC(I,K))RA(I,J)=RA(I,J)+.5
0052          IF(SC(I,J).GT.SC(I,K))RA(I,J)=RA(I,J)+1
0053    4     CONTINUE
0054          DO 60 I=1,NK
0055          DO 60 J=1,NR
0056    60    RS(I)=RS(I)+RA(J,I)
0057          DO 22 I=1,NK
0058    22    SUM=SUM+RS(I)
0059          SUM=SUM/NK
0060          DO 21 I=1,NK
0061    21    S=S+(RS(I)-SUM)**2
0062          IF(ITIES.EQ.0)GO TO 61
0063          DO 32 J=1,NR
0064          N=1
0065          SUM=0
0066          DO 31 I=1,NK
0067          M=1
0068          K2=I+1
0069          DO 30 K=K2,NK
0070          IF(RA(J,I).NE.RA(J,K))GO TO 30
0071          M=M+1
0072          D(N)=RA(J,I)
0073    30    CONTINUE
0074          IF(M.EQ.1)GO TO 31
0075          DO 29 K1=1,N
0076          IF(N.EQ.K1)GO TO 28
0077          IF(D(N).EQ.D(K1))GO TO 31
0078    29    CONTINUE
0079    28    SUM=SUM+(M**3-M)
0080          N=N+1
0081    31    CONTINUE
0082          IF(N.EQ.1.AND.SUM.EQ.0)GO TO 32
0083          T=T+SUM/12
0084    32    CONTINUE
0085    61    ANK=NK
0086          ANR=NR
0087          WK=S/(((((ANR**2)*(ANK**3-ANK))/12)-(ANR*T))
0088          CHIK=ANR*(ANK-1)*WK
0089          NDFK=NK-1
0090          ARB=(ANR*WK-1)/(ANR-1)
0091          SBR=ANR*ARB/(1+(ANR-1)*ARB)
0092          IF(ITIES.EQ.1) GO TO 52
0093          WRITE(IUNIT,53)
0094    53    FORMAT(1H1," DATA CALCULATED WITHOUT CORRECTION FOR TIES")
0095          GO TO 51
0096    52    WRITE(IUNIT,54)
0097    54    FORMAT(1H1," DATA CALCULATED WITH CORRECTIONS FOR TIES")
0098    51    WRITE(IUNIT,9)CHIK,NDFK
0099    9     FORMAT(" CHI SQUARE FOR R= ",F8.3," ,DEGREES OF FREEDOM =",I3)
0100          WRITE(IUNIT,10)WK
0101    10    FORMAT(" KENDALL'S W= ",F6.3)
0102          WRITE(IUNIT,11)ARB,SBR
0103    11    FORMAT(" AVERAGE ROW RELIABILITY = ",F6.3," TOTAL REL",
0104         1"IABILITY = ",F6.3,//)
0105          WRITE(IUNIT,936) S
```

```
0106   936    FORMAT("       S = ",5X,F10.5,//)
0107          IF(ICOM.NE.1) STOP
0108          DO 200 I=1,30
0109   200    DR(I)=0
0110          NKR=NK-1
0111          DO 12 I=1,NKR
0112          II=I+1
0113          DO 12 J=II,NK
0114          NN=NR
0115          DO 13 K=1,NR
0116   13     D(K)=SC(K,I)-SC(K,J)
0117          NPLUS=0
0118          DO 14 K=1,NR
0119          IF(D(K).EQ.0)DR(K)=0
0120          IF(D(K).EQ.0)NN=NN-1
0121          IF(D(K).EQ.0)GO TO 14
0122          IF(D(K).GT.0)NPLUS=NPLUS+1
0123          DR(K)=.5
0124          DO 14 L=1,NR
0125          IF(D(L).EQ.0)GO TO 14
0126          IF(ABS(D(K)).EQ.ABS(D(L)))DR(K)=DR(K)+.5
0127          IF(ABS(D(K)).GT.ABS(D(L)))DR(K)=DR(K)+1
0128   14     CONTINUE
0129          NNN=(NN/2)
0130          T=0
0131          IF(NPLUS.GT.NNN)GO TO 16
0132          DO 17 K=1,NR
0133          IF(D(K).GT.0)T=T+DR(K)
0134   17     CONTINUE
0135          GO TO 19
0136   16     DO 18 K=1,NR
0137          IF(D(K).LT.0)T=T+DR(K)
0138   18     CONTINUE
0139   19     FNN=NN
0140          TOP=FNN*(FNN+1)/4
0141          BOT=SQRT(TOP*(2*FNN+1)/6)
0142          ZEE=(T-TOP)/BOT
0143          IF(NN.LT.6)GO TO 100
0144          IF(NN.GE.6.AND.NN.LE.25)GO TO 101
0145          PR=.5
0146          IF(ZEE.GE.1.96)PR=.05
0147          IF(ZEE.GE.2.327)PR=.02
0148          IF(ZEE.GE.2.575)PR=.01
0149          GO TO 102
0150   101    PR=.5
0151          IF(ABS(ZEE).GE.TAB(NN,1))PR=.05
0152          IF(ABS(ZEE).GE.TAB(NN,2))PR=.02
0153          IF(ABS(ZEE).GE.TAB(NN,3))PR=.01
0154          GO TO 102
0155   100    PR=.5
0156   102    WRITE(IUNIT,20)I,J,ZEE,NN,PR
0157   20     FORMAT(" VAR ",I3," AND VAR ",I3,"   WILCOXIN SIGNED RANK Z =",
0158          XF8.3,"   # OF PAIRS = ",I3,"   ALPHA LEVEL S GNIFICANCE =",F8.3,
0159          X//)
0160   12     CONTINUE
0161   333    STOP
0162          END
0163          END$
```

```
0001   FTN4
0002          PROGRAM CTAPE
0003          COMMON SC(70),INAME(3),IFMT(20),IB(272),IBUF(256)
0004          WRITE(1,121)
0005   121    FORMAT("ENTER DATA FILE NAME")
0006          READ(1,98) INAME
0007   98     FORMAT(3A2)
0008          WRITE(1,194)
0009          REWIND 8
0010          READ(1,*) ITIES
0011   194    FORMAT( " DO YOU WISH TO COMPUTE WITH TIES 1=YES, 0=NO ")
0012          WRITE(1,195)
0013          READ(1,*) NK
0014   195    FORMAT(" NUMBER OF COLUMNS (MAX 70) :    ")
0015          WRITE(1,196)
0016   196    FORMAT(" NUMBER OF ROWS (MAX 30) :     ")
0017          READ(1,*) NR
0018          WRITE(1,198)
0019   198    FORMAT(" ENTER DATA FORMAT")
0020          READ(1,199)IFMT
0021   199    FORMAT(20A2)
0022          WRITE(1,987)
0023   987    FORMAT(" ENTER 6 FOR LINE PRINTER OUTPUT, 1 FOR CRT")
0024          READ(1,*) IUNIT
0025          WRITE(1,45)
0026   45     FORMAT("ENTER 1 FOR RAW DATA PRINTOUT, ELSE ENTER 0")
0027          READ(1,*) IPTO
0028          WRITE(1,393)
0029   393    FORMAT("DO YOU WANT WILKOXIN SIGN RANK Z  ? , 1=YES, 0=NO")
0030          READ(1,*) ICOM
0031          WRITE(1,88)
0032   88     FORMAT(" ENTER THE RECORD LENGTH AS IN DA30")
0033          READ(1,*) LENGTH
0034          LEN=LENGTH/2
0035          IF((LEN*2).NE.LENGTH) LEN=LEN+1
0036          LENGTH=LEN
0037          IDCBS=LENGTH
0038          IF(LENGTH.LT.144) IDCBS=144
0039          CALL OPEN(IB,IER,INAME,3,0,-2,IDCBS)
0040          IF(IER.GE.0) GO TO 123
0041          WRITE(1,145) INAME,IER
0042   145    FORMAT(3A2,"  FAILED TO OPEN , IER = ",I5)
0043          WRITE(8,20) IER,ICOM
0044   20     FORMAT(2I5)
0045          REWIND 8
0046          STOP 145
0047   123    CONTINUE
0048          WRITE(8,20) IER,ICOM
0049          WRITE(8,204) ITIES,NK,NR,IUNIT
0050   204    FORMAT(4I5)
```

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```
0051           WRITE(8,205) IFMT
0052    205    FORMAT(20A2)
0053           DO 10 I=1,NR
0054           CALL READF(IB,IER,IBUF)
0055           CALL CODE
0056           READ(IBUF,IFMT) (SC(J),J=1,NK)
0057           WRITE(8,IFMT) (SC(J),J=1,NK)
0058           IF(IPTO.EQ.1) WRITE(IUNIT,209) (SC(J),J=1,NK)
0059    209    FORMAT(8F10.4)
0060           IF(IPTO.EQ.1) WRITE(IUNIT,2090)
0061    2090   FORMAT(5X)
0062    10     CONTINUE
0063           REWIND 8
0064           CALL CLOSE(IB)
0065           END
0066           END$
```

CHISQ   (Chi-square)

Purpose:

> This program performs a chi-squared test for independence on a
> row by column (R x C) contingency table and calculates the con-
> tingency coefficient.

Layout of Design:

	A_1	A_2	. . . . .	A_c	Total
B_1	ab_{11}	ab_{12}	. . . . .	ab_{1c}	$R_{1.}$
B_2	ab_{21}	ab_{22}	. . . . .	ab_{2c}	$R_{2.}$
.	.	.	. . . . . .	.	.
.	.	.	. . . . . .	.	.
.	.	.	. . . . . .	.	.
.	.	.	. . . . . .	.	.
B_r	ab_{r1}	ab_{r2}	. . . . . .	ab_{rc}	$R_{r.}$
Total	$R_{.1}$	$R_{.2}$		$R_{.c}$	N

where:

$R_{.i}$ = total in $i\underline{th}$ column

$R_{j.}$ = total in $j\underline{th}$ row

N = overall total

Mathematical Model:

$$x^2 = \sum_{j=1}^{R} \sum_{i=1}^{C} \left[\frac{(O_{ij} - E_{ij})^2}{E_{ij}} \right]$$

where:

O_{ij} = observed value in i, $j\underline{th}$ position.

E_{ij} = expected value in i, $j\underline{th}$ position = $R_{.i} * R_{j.}/N$

The hypothesis to be tested is:

$$Ho: \quad A_1 = A_2 = A_3 = A_c$$

User Considerations and Procedures:

1. Program expects data in a R x C matrix form. A printout of raw data would show C data points per line.

2. The data analysis can be either displayed on the CRT or a hard-copy can be obtained from the line printer. Option: 1 for CRT output, 6 for line printer output.

3. A printout of the raw data can be obtained. Option: 1 if raw data printout is desired, 0 for no printout. The output device is designated by the above option (#2).

4. Parameters required:

   a. number of columns (maximum 100)

   b. number of rows (maximum 100)

   c. data file name

   d. format and record length of data file (see DA30)

5. Printout gives:

   a. raw data if optioned

   b. calculated chi-squared value with d.f. = $(R - 1)*(C - 1)$

   c. the contingency coefficient, $C = (X^2/(X^2 + N))**.5$

Comments:

Program provides calculated chi-squared value which can be compared to a critical chi-square table to determine probability.

Test Data:

This program was tested using data from S. Siegel, Nonparametric Statistics for the Behavorial Sciences, McGraw-Hill, 1956, P. 198. Program uses double precision for accuracy.

287

```
  RU,CHISO
CHI-SQUARED TEST FOR INDEPENDENCE OF A RXC
    CONTINGENCY TABLE AND THE CONTINGENCY COEFFICIENT
    INPUT FILE NAME
#CHISO
 ENTER DATA FORMAT
(4(1X,F4.0))
NUMBER ACROSS
4
THE NUMBER DOWN:
3
 ENTER THE RECORD LENGTH AS IN DA30
20
ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0
1
ENTER 1 FOR CRT OR 6 FOR LINEPRINTER OUTPUT
6

THE CONTINGENCY COEFFICIENT =   .38865
:
```

RAW DATA

```
23.     40.     16.      2.
11.     75.    107.     14.
 1.     31.     60.     10.
```

CHI-SQAURED = 69.3893283   DEGREES OF FREEDOM = 6

```
0001   FTN4
0002          PROGRAM CHISQ
0003          DOUBLE PRECISION E,X,Y,Z,CHIS,C,TOTAL
0004          DIMENSION X(100),Y(100),Z(100),NAME(3),IFMT(20)
0005          DIMENSION IB(272),IBUF(256)
0006          IUNIT=1
0007          WRITE(1,981)
0008   981    FORMAT("CHI-SQUARED TEST FOR INDEPENDENCE FO A RXC ",/,
0009          $"    CONTINGENCY TABLE AND THE CONTINGENCY COEFFICIENT")
0010          WRITE(1,1111)
0011   1111   FORMAT("  INPUT FILENAME")
0012          READ(1,1)NAME
0013   1      FORMAT(3A2)
0014          WRITE(1,1112)
0015   1112   FORMAT(" ENTER DATA FORMAT")
0016          READ(1,54)IFMT
0017   54     FORMAT(20A2)
0018          WRITE(1,1113)
0019   1113   FORMAT ("NUMBER ACROSS")
0020          READ(1,*) NC
0021          WRITE(1,114)
0022          READ(1,*) NR
0023   114    FORMAT ("THE NUMBER DOWN :    ")
0024          TOTAL=0.
0025          CHIS=0.
0026          IDCBS=256
0027          CALL OPEN(IB,IER,NAME,3,0,-2,IDCBS)
0028          IF(IER.GE.0) GO TO 123
0029          WRITE(1,124) NAME,IER
0030   124    FORMAT(3A2,"  FAILED TO OPEN , IER = ",I5)
0031          STOP 123
0032   123    CONTINUE
0033          WRITE(1,459)
0034   459    FORMAT("ENTER 1 FOR PRINTOUT OF RAW DATA, ELSE ENTER 0")
0035          READ(1,*) IPTO
0036          WRITE(1,56)
0037   56     FORMAT("ENTER 1 FOR CRT OR 6 FOR LINPRINTER OUTPUT")
0038          READ(1,*) IUNIT
0039          IF(IPTO.NE.1) GO TO 987
0040          WRITE(IUNIT,3679)
0041   3679   FORMAT(/,"RAW DATA",/)
0042   987    WRITE(IUNIT,913)
0043   913    FORMAT(///)
0044          DO 100 J=1,NR
0045          CALL READF(IB,IER,IBUF)
0046          CALL CODE
0047          READ(IBUF,IFMT) (X(I),I=1,NC)
0048          IF(IPTO.EQ.1) WRITE(IUNIT,IFMT) (X(I),I=1,NC)
0049          DO 100 I=1,NC
0050          Y(I)=Y(I)+X(I)
```

```
0051        Z(J)=Z(J)+X(I)
0052  100   CONTINUE
0053        DO 101 J=1,NC
0054  101   TOTAL=TOTAL+Y(J)
0055        CALL RWNDF(IB)
0056        DO 200 J=1,NR
0057        CALL READF(IB,IER,IBUF)
0058        CALL CODE
0059        READ(IBUF,IFMT)(X(I),I=1,NC)
0060        DO 200 I=1,NC
0061        E=Y(I)*Z(J)/TOTAL
0062  200   CHIS=CHIS+(X(I)-E)*(X(I)-E)/E
0063        N=(NC-1)*(NR-1)
0064        C=DSQRT(CHIS/(CHIS+TOTAL))
0065        WRITE(IUNIT,9876) CHIS,N
0066  9876  FORMAT(//,5X,"CHI-SQUARED =",F14.7,10X,,"DEGREES OF FREEDOM ="
0067       C,I5)
0068        WRITE(IUNIT,1115) C
0069  1115  FORMAT(//" THE CONTINGENCY COEFFICIENT =   ",F10.5)
0070        CALL CLOSE(IB)
0071        END
0072        END$
```

APPENDIX A

GENERALIZED SUBROUTINES

APPENDIX A

GENERALIZED SUBROUTINES

FPROB and YNORM are subroutines used in many of the statistical programs. FPROB calculates the probability value for the F-statistic in the analyses of variance and covariance programs. There are five arguments for FPROB (F, DF1, DF2, Z, and P). The three parameters passed to the subroutine are the F-statistic value and the two degrees of freedoms associated with the F. The return parameters are the Z-value and the probability calculation, P. YNORM is used to normalize scores. There are two arguments for YNORM (DZ, YORMX). DZ is the initial score value which is passed to the subroutine; YORMX is the recalculated score that is returned to the original program. Program listings for these two subroutines are on the following pages.

```
0001   FTN4,L
0002          SUBROUTINE FPROD(F,DF1,DF2,Z,P)
0003          DOUBLE PRECISION EDF1,EDF2,FA,T,A,B,TOP,BOT,CA,CB,CC,CD
0004          DOUBLE PRECISION F,DF1,DF2,Z,P
0005          P=1.0
0006          EDF1=DF1
0007          EDF2=DF2
0008          FA=F
0009          IF(F.LE.0.)GO TO 100
0010          IF(EDF1.LE.0.)GO TO 100
0011          IF(EDF2.LE.0.)GO TO 100
0012          IF(F.GE.1.0)GO TO 60
0013          FA=1.0/F
0014          T=EDF1
0015          EDF1=EDF2
0016          EDF2=T
0017   60     A=2./(9.*EDF1)
0018          B=2./(9.*EDF2)
0019          TOP=(1.-B)*FA**(1./3.)-1.+A
0020          BOT=DSQRT(B*FA**(2./3.)+A)
0021          Z=DABS(TOP/BOT)
0022          IF(EDF2.GT.3.)GO TO 80
0023          Z=Z*(1.+.08*Z**4/EDF2**3)
0024   80     CA=.196854
0025          CB=.115194
0026          CC=.000344
0027          CD=.019527
0028          T=Z*(CA+Z*(CB+Z*(CC+Z*CD)))
0029          T=(1.+T)**4
0030          P=.5/T
0031          IF(F.GE.1.0)GO TO 100
0032          P=1.-P
0033   100    RETURN
0034          END
0035          END$
```

```
0001   FTN4
0002          SUBROUTINE YNORM(DZ,YORMX)
0003          DOUBLE PRECISION DZ,DPI,YORMX,DX,DAL,DBL,DAH,DBH,DAN,DBI,DAI,
0004         $DFA,DFB,DAC,DBC
0005          DPI=.3989422804014<33
0006          DX=DABS(DZ)
0007          YORMX=0.0D0
0008          IF(DZ.LT.-18.70) GO TO 99
0009          YORMX=1.D0
0010          IF(DZ.GT.9.D0) GO TO 99
0011          IF(DX.GT.3.D0) GO TO 10
0012          DAL=0.0D0
0013          DBL=1.0D0
0014          DAH=DX
0015          DBH=1.D0
0016          DAN=0.0D0
0017   5      DAN=DAN+1.0D0
0018          DAI=-(2.D0*DAN-1.D0)*DX*DX
0019          DBI=4.D0*DAN-1.D0
0020          DAL=DBI*DAH+DAI*DAL
0021          DBL=DBI*DBH+DAI*DBL
0022          DAI=DX*DX-DAI
0023          DBI=2.D0+DBI
0024          DAH=DBI*DAL+DAI*DAH
0025          DBH=DBI*DBL+DAI*DBH
0026          DFA=DAL/DBL
0027          DFB=DAH/DBH
0028          IF(DFB.EQ.0.D0) GO TO 20
0029          IF(DABS((DFB-DFA)/DFA).LE.1.D-10) GO TO 20
0030          GO TO 5
0031   10     DAL=0.0D0
0032          DBL=1.0D0
0033          DAH=1.0D0
0034          DBH=DX
0035          DBI=DX
0036          DAN=1.D0
0037          DFA=1.D0/DX
0038   15     DAN=DAN+1.0D0
0039          DAI=DAN-1.D0
0040          DAC=DBI*DAH+DAI*DAL
0041          DBC=DBI*DBH+DAI*DBL
0042          DFB=DAC/DBC
0043          DAL=DAH
0044          DBL=DBH
0045          DAH=DAC
0046          DBH=DBC
0047          IF(DFB.EQ.0.D0) GO TO 20
0048          IF(DABS((DFB-DFA)/DFB).LE.1.D-10) GO TO 20
0049          DFA=DFB
0050          GO TO 15
0051   20     YORMX=DPI*DFB*DEXP(-DX*DX/2.D0)
0052          IF(DX.LE.3.D0) YORMX=0.5D0-YORMX
0053          IF(DZ.GT.0.D0) YORMX=1.0D0-YORMX
0054   99     RETURN
0055          END
0056          END$
```

A-3

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The Statistical Package User's Guide represents an aggregation of a variety of statistical analysis. The types of statistical programs available are: Analysis of Variance, Analysis of Covariance, Multivariate Analysis of Variance, Regression Analysis, Factor Analysis, Descriptive Statistics, and Non-parametric Statistics. The User's Guide provides the following documentation for each program: General Description, Mathematical Model, Operational Procedures, Test Data Statistical Analysis, and Software coding.
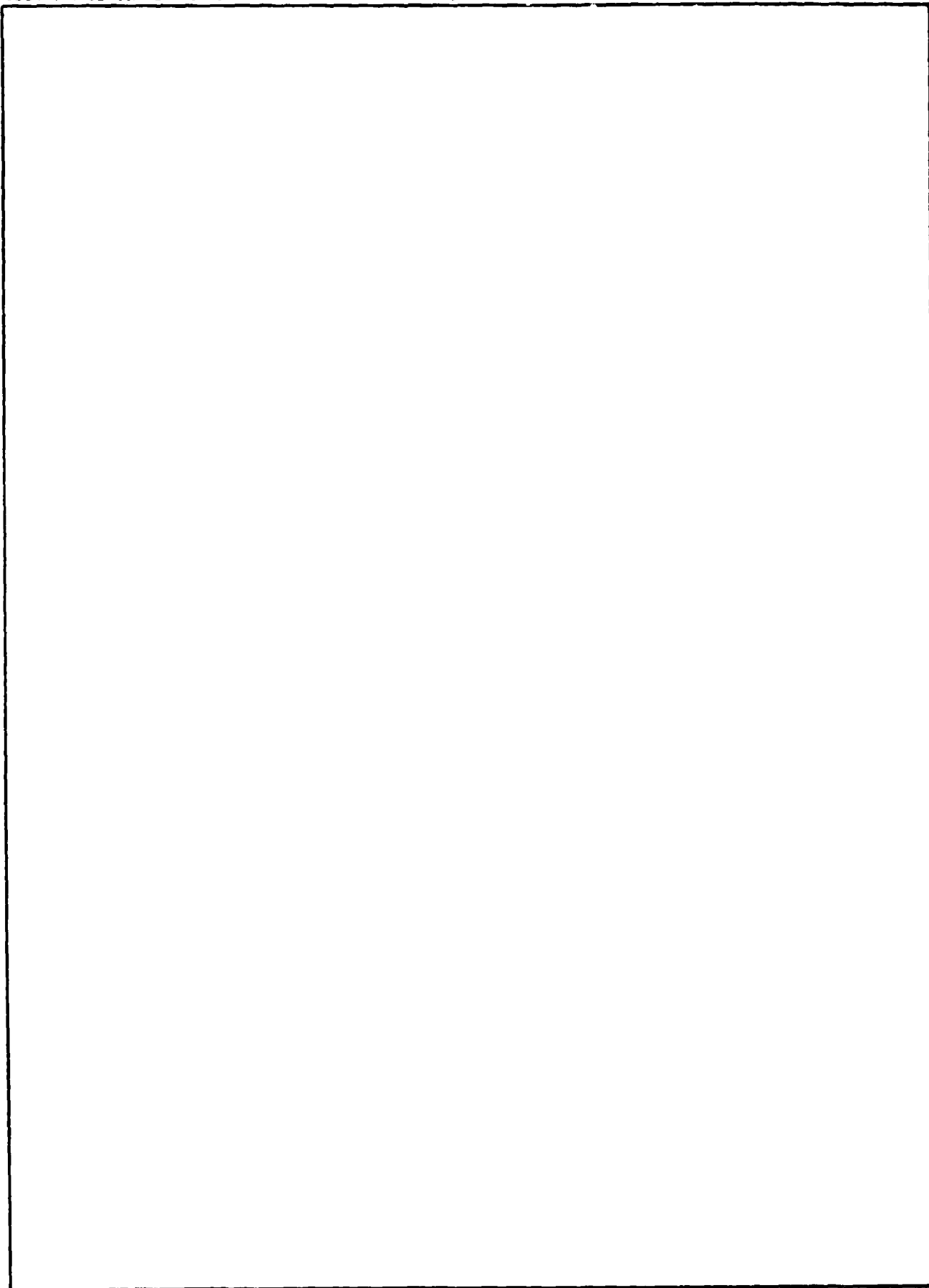
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